மெய்ப்பொருள் காண்பதறிவு

ok

Volume IX No. 2

Journal

DECEMBER 1980

4316

Madurai Kamaraj University

JOURNAL OF MADURAI KAMARAJ UNIVERSITY

(PUBLISHED HALF-YEARLY)

EDITORIAL BOARD

:: :: ::

President:

Prof. J. RAMACHANDRAN, M. A., A. M. (chicago)
VICE-CHANCELLOR
MADURAI KAMARAJ UNIVERSITY

Members:

Dr. (Mrs.) KOTHAI PILLAI
HEAD, DEPARTMENT OF EDUCATION

Dr. R. VENKATARATNAM
HEAD, DEPARTMENT OF SOCIOLOGY

Dr. S. KRISHNASWAMY
HEAD, SCHOOL OF BIOLOGICAL SCIENCES

Editor:

Dr. K. R. NAGARAJAN
HEAD, SCHOOL OF MATHEMATICS

Vol. IX - No. 2

1980

(Issued February 1983)

Published by the Madurai Kamaraj University

Journal of Madurai Kamaraj University

Annual Subscription

Foreign

Institutions	$	20	00
Individuals	$	10	00

India

Institutions	Rs.	30	00
Individuals	Rs.	20	00

(Inclusive of Postage)

Advertisement Tariff

For one issue-Full Page	Rs.	250	00
For one issue-Half Page	Rs.	150	00

Series A

Humanities

	Author	Title	Page No.
1.	L. C. Thanu	Bread and Freedom – The Gandhian way	1
2.	E. Swaminathan	A Study on the locational characteristics distribution pattern and trade areas of weekly markets in Coimbatore District Tamilnadu.	7
3.	G. Mani	Pre and Post-Natal care among slum mothers	13
4.	P. K. Sasidharan	A critical note on the way to attain the goal of life in the Samkhya and the Yoga Philosophies	19
5.	K. Gowri	Peter Pandia	23
6.	S. Selvinkumar	A brief account of the Eastern Muslim historians of the Twelfth century	27
7.	M. V. Satchitanandam	Determinants of Food grains prices in Indian Economy: 1951—'64	31
8.	G. Subramanian	Factor productivity and regional efficiency in Indian Sugar Industry	37
9.	E. S. A. Ramanaganga & N. Subramanian	Love poems of Robert Burns - A Study	43
10.	D. Chandra	Ranking of Biochemical Journals: A citation analysis study	47

BREAD AND FREEDOM—THE GANDHIAN WAY

L.C. THANU,
S.T. Hindu College, Nagercoil.

ABSTRACT

Democracy means bread and freedom. To barter one for the other is a bad bargain. Capitalism guarantees freedom but not bread Socialism ensures bread sans freedom. Only the Sarvodaya order, as envisaged by Mahatma Gandhi, could guarantee bread with dignity and without loss of liberty. Such an order becomes possible only if people, through change of heart, become disciplined, unselfish and service-minded. This is really a big 'if'.

In the words of Swift, "bread is the staff of life". The old testament,however, avers, "man shall not live by bread alone". Man craves for freedom, for, in the words of William Cowper,

> "Freedom has a thousand charms to show,
>
> That slaves, howe'er contented, never know".

R.G. Ingersoll says :

> "What light is to the eyes
> What air is to the lungs,
> What love is to the heart,
> Liberty is to the soul of man"

He does not hesitate to sacrifice his all for freedom, or else, in a country like ours with about forty percent of the population living below poverty line, the majority would prefer to be in jails, where the Government spends about rupees ten per head per day, which is much above the per capita income of an Indian. The mythological story of Prahalatha defying his father to exercise his freedom of worship is an instance in point. Recent history is replete with cases of intellectuals taking refuge in the U.S A. to enjoy the freedom of expression.

Barbara Wotton says : "The freedoms that matter in ordinary life are definite and concrete, and they change with the changing ways of different ages and different civilizations" (Wootton, *Freedom under Planning*, 9). Freedom may be of various types and degrees. Broadly speaking there are four types of freedom, which an individual enjoys in a civilized society. They are : cultural freedom, civil freedom, political freedom, and economic freedom. Cultural freedom is the freedom of a citizen to live according to the customs, usages and traditions of his community. Civil freedom refers to the constitutional rights guaranteed to the citizen such as the right to trial in a court of law before being imprisoned for specific offences. Political freedom stands for the right of the citizen to participate in the formation of the Government through voting and the right to form opposition parties. Economic freedom includes the right to hold private property, freedom of consumption, freedom of enterprise, freedom to choose occupation and economic security.

The great Thiruvalluvar, the author of the immortal work 'Thirukkurul' (30 B.C.) postulates three fundamental freedoms for the individual citizen: (i) Freedom from hunger (ii) Freedom from disease and (iii) Freedom from fear — arising out of aggression from within and without.

Freedom does not, however, imply unlimited freedom to do what one pleases. It is not absolute freedom or licence but liberty subject to controls imposed in the interest of the society A wise judge once said that the freedom of movement enjoyed by one's fist is limited to the distance of one's neighbour's nose.

Democracy means bread and freedom; one is a physical necessity and the other a psychological one. The Government must guarantee a minimum standard of living and reasonable freedom to enable the citizens to grow to their fullest stature. To barter one for the other is a bad bargain.

In the modern political set up, however, there is a lurking apprehension that people have to forego

one for the sake of the other. It is often remarked that capitalism ensures freedom though not bread and that socialism guarantees bread sans freedom. This is a fallacious statement.

Under capitalism, people enjoy freedom of enterprise, freedom of Contract, freedom to use their property and freedom of consumption, with the least governmental interference All these lack substance, for, without freedom from want, all other freedoms are meaningless. For example, under capitalism a man is said to be free to choose his work. But it does not mean a 'right to work'. Freedom to choose one's occupation has meaning only when job opportunities are plentiful. Further there is no equality of opportunity; family influence, affluence of the individual, prejudices and other social restrictions determine one's choice of occupations. The result is that only poorly-paid ones are open to the poor. Similar is the case with the myth regarding consumer's sovereignty; the consumer is no longer a sovereign He is an impotent king deprived of his throne and crown and reduced to the level of an abject slave, a victim of exploitation by cunning businessmen. His capacity to consume is conditioned by his income; his poverty is a serious constraint. He likes to buy pure ghee but he has to content himself with Dalda for want of funds Through high-pressure salesmanship and persistent expensive and attractive advertisement, easily gullible consumers are forced to buy what is supplied in the market. Goods are produced mostly to cater to the vagaries of the rich. The rich cast much larger 'rupee votes' and this is a negation of consumer's democracy. As D H. Robertson puts it, "the luxurious fancies of the rich exert a stronger pull on the productive resources of the community than the stark needs of the poor" (D. H. Robertson, The Control of Industry, 87).

In fact, the masses have no real freedom. There is economic instability and consequent unemployment, making the workers, who constitute the bulk of the nation, live under a perpetual dread of losing their job. Human welfare is ignored.

There exist wide economic inequalities. As G. D H Cole remarks "There is a world of difference in terms of happiness between the high priest and the slaves in the temple of industry" (K K. Dewett, "Modern Economic Theory", 1130) While a few roll on the lap of wealth, the poor millions groan under the grip of poverty. The idle rich enjoy a luxurious life, whereas the poor cannot get even two square meals a day in spite of unremitting labour, and sink in squalor, poverty and misery. They are dressed in rags and live in hovels and their children often die for want of milk and medicine, whereas even the dogs and horses of the rich are better fed and well-kept. The sorry spectacle of crops rotting, while human beings are starving, and machines lying idle inside the factories, while unemployment is raging in all its fury outside, is not uncommon.

Capitalism is an economic system of the rich, by the rich and for the rich and exists to perpetuate the vested interests at the expense of the poor. The much-talked-about freedom is just a farce vis-a vis the have-nots. Have the downtrodden the necessary finance to fight against the injustices of the rich in a court of law? Can a poor man easily win an election to the Parliament? Is it not too much to claim that he can? In short, there is neither bread nor freedom for the multitude. Even in European countries, where conditions are much better, the lot of the poor is definitely miserable, when compared with their rich brethren. However, there has been a perceptible improvement in the living standards of the poor during the last few years, thanks to the governmental welfare measures aiming at protecting the people from the "womb to the tomb".

Socialism is an economic system, which abolishes private property, introduces common ownership of the means of production, guarantees equality of opportunity, reduces economic inequalities, provides full employment and economic security, ensures economic liberty for the individual by guaranteeing the right to work and a minimum standard of living, saves the consumers from exploitation and confers dignity on individuals.

Socialism envisages State-control over a wide range of human activities Man becomes a mere cog in the giant wheel of the State. He loses his freedom. He has to function in accordance with the dictates of a central organisation. He has no free choice of occupations. Workers will be assigned certain jobs and they cannot change them without the consent of the planning authority. Every worker is dovetailed in the scheme and he has to remain there. Even in matters of consumption, he has no choice. He has to satisfy himself with what is supplied to him. Consumption will have to adjust itself to production. He will

not be able to maximise his satisfaction. The mad craze for foreign consumer goods in the U.S.S R. illustrates this. Socialism, therefore, means, hardship, sacrifice and privation for the consumer.

To adduce that there is no freedom in the Soviet Union, the critics usually cite an interesting discussion among three surgeons as to which of the operations was the most difficult. The English surgeon suggested open heart surgery while the American, brain surgery. The Russion surgeon looked around and in a subdued tone suggested that the most difficult of all the operations is the removal of tonsils since throat surgery in Russia has to be conducted only through the ears, as none could open the mouth. Freedom of expression is one's birth right; if denied, one becomes an automaton, a rabot. Gandhiji says: 'I want freedom for full expression of my personality. Under socialism, there is no individual freedom. You own nothing, not even your body' (Harijan, 1946). "Where there is no freedom of thought and action, there can be no religion. In the absence of religion, a people cannot but perish" Mahadevan, "Gandhi Marg". 1971)

Under Socialism, there is no unemployment. True, the worker is employed, but the job is not of his choice. He gets food, clothing and shelter but not according to his taste. because the State is not concerned with the specific wants of isolated individuals but only with the general wants of the society. The critics of socialism point out that in jails too, prisoners get work and food; and they regard a socialist State as one big prison-house and they do not think that employment and food are adequate compensation for the loss of liberty.

To sum up, neither capitalism which secures better production and fosters individual liberty and individual development nor socialism which brings about better distribution and promotes collective peace and happiness can provide both bread and freedom to the toiling millions all over the world. Democracy to survive must find a speedy solution to this by evolving a new economic order, wherein people are guaranteed the right to work and the right to live as free citizens.

It is in this context that Gandhian philosophy gains a sharp relevance. Mahatma Gandhi suggested an alternative world-order called 'Sarvodaya' or the welfare of all to the 'immoral world of competition and exploitation" on the one hand, and "the soulless mechanical world of regimentation" on the other. It is a society of high order, partaking the character of "Kingdom of God.

Dr. V. K. R. V. Rao says: A Sarvodaya order is "a classless society based on destruction of the classes but not on the destruction of the individuals, who constitute the classes, a system of production that does not fail to make use of science and technology for creating an economy of abundance but does not in the process either kill individual initiative, or freedom for development nor create a psychology of ceaseless striving for more and more of material goods; a system of distribution that will ensure a reasonable minimum income for all and, while not aiming at a universal equality of an arithmetical kind, will nevertheless ensure that all private property or talent beyond the minimum will be used as a trust for the public good and not for individual aggrandisement; a social order where all will work but there is no inequality, either in status or in opportunity for any individual, and a political system where change is the result of persuasion, differences are resolved by discussion and conflicts by love and recognition of mutuality of interest" (Rao, V.K.R.V. The Gandhian alternative to Western Socialism, 36-37).

Sarvodaya society will comprise numerous autonomous and self sufficient villages. Each village will be a 'family writ-large' and the same values that hold true in the case of the family will hold good for the village society also The law of bread labour and the doctrine of trusteeship will be in operation. Such a society ensures social justice, according to which "each gets in proportion to his needs and gives in proportion to his capacity". There will be freedom to work but no freedom from work. There will be justice and equality and no exploitation. Hence people would be happy. Power and authority would vest with people who would be their own masters. There will be thus perfect democracy based upon non-violence, individual freedom, responsibility, economic equality, fraternity, autonomy, justice, decentralised economic system, co-operative way of life and welfare of all.

The sarvodaya order lays emphasis on the divine law of bread labour, first stressed by the Russian Writer, T. M Bondaref and later popularised by Tolstoy. The economics of bread labour, which Gandhiji calls "the living way of life", means that man must earn his bread by labouring with his own

hands. 'Bread' is symbolic of the indispensable primary necessaries of life. These require productive labour and one who enjoys them without properly sharing in the labour is a thief. "Earn thy bread by the sweat of thy brow", says the Bible. "He who eats without offering sacrifice eats stolen food". Thus says the Gita. Gandhiji proclaimed: "It is only when a man or woman has done bodily labour for the sake of service that he or she gets any right to live". The rich who multiply treir wants and avoid manual labour really exploit the labour of the poor using the latter as mere means for their gratification. Gandhiji feels that if people were convinced of the value and necessity of bread labour and laboured, then there would be enough bread and clothing and enough leisure for all. There would also be no cry of over-population, no disease, no class distinctions and no such misery as we see around.

Foods is as old as man and is the first among our primary necessities. The ideal form of body labour, therefore, should be related to agriculture. If that is not possible, body labour should take the form of any other productive manual work connected with some primary need, e. g. spinning, weaving, carpentry, smithery, etc. Everyone must be his own scavenger. Bread labour however, does not include intellectual labour. For, "the needs of the body must be supplied by the body". Gandhiji insisted on physical labour for all, including the intellectuals.

Bread labour, which Gandhiji considers as the highest form of social service, should be voluntary and not compulsory. "Compulsory obedience to the Law of Bread Labour breeds poverty, disease and discontent. It is a state of slavery. Willing obedience to it must bring contentment and health. And it is health which is real wealth, not pieces of siver and gold".

Bread labour may be an unattainable ideal. But we need not, therefore, cease to strive for it. Even if, without fulfilling the whole law, we performed physical labour enough for our daily bread, we could go a long way towards the ideal. The remuneration for intellectual workers should be equal to that of manual workers. Earnings in excess of what is necessary for one's requirement must be used for the good of the community. In other words, over-possession should go with trusteeship.

Gandhiji advocated simple living and high thinking. He stood for voluntary reduction of wants. According to him, "civilization in the real sense of the term consists, not in the multiplication but in the deliberate and voluntary reduction of wants". "Craze for multiplicity of goods is destructive of contentment, peace and tranquility. It results in exploitation, enormous waste of nature's material and human labour, and in ever preparedness for war". (T. S. Devadoss - "Sarvodaya and the problems of Political Sovereignty"- 273). Dr. Bharatan Kumarappa rightly observes: "A man whose needs are few such as can be met by himself can afford to raise his head high and refuse to bow to any power which seeks to enslave him. Not the man with so-called high standard of living. Every new luxury he adopts becomes an additional fetter preventing him from freedom of thought, movement and action". (Bharatan Kumarappa, "Capitalism, Socialism or Villagism", 28).

With limited wants and a readiness to do manual labour, it becomes possible to achieve self-sufficiency with regard to our primary requirements of food, clothing and shelter; the charka too is a means to achieve this end. All these promote economic independence and self-reliance and foster a spirit to solve our problems ourselves without looking for outside aid. Self-reliance is the basis of freedom, while dependence on others is the essence of slavery. Experience has taught us that strings will always be attached to economic aid from abroad, leading to loss of freedom. Gandhiji said: "The first lesson we must learn is of self-help and self-reliance. If we assimilate this lesson, we shall at once free ourselves from disastrous dependence upon foreign countries and ultimate bankruptcy This is not said in arrogance but as a matter of fact. We are not a smal place, dependent for its food supply upon outside help" (K. Vasudevan, "Gandhian Economics", 48). He cannot tolerate the idea of the people being made to depend on the Government for this most primary need of life He can understand the Government stepping in during emergencies like war to tide over the effects of economic dislocation. But the continuance of control and rationing even when the war was over, he regarded as positively wrong. He said that "decontrol means that the business of foresight is transferred from few members of the Government to the millions composing the nation" (K. Vasudevan,"Gandhian Economics",48).

Freedom is necessary for a just and righteous life and its achievement is the highest pursuit of truth. Gandhi's philosophy was based on an implicit faith in the freedom of the human soul. With Kant, Gandhi believed that freedom was a basic postulate of morality. He conceived of freedom in terms of "the freedom of man in all his majesty". To him, freedom—national, moral and spiritual—was an integral whole and as such indivisible. The individual loomed large in his thinking. He stressed the spiritual potentialities of the individual; enjoyment of full freedom by the individual was of utmost importance to him. He therefore repudiated everything that suppressed freedom as being based on sin and untruth. "To deprive a man of his natural liberty" he said, is worse than starving his body. It is starvation of the soul. No amount of .... literary education or even economic betterment will restore the lost dignity of man". Gandhi once wrote: we must first make good the right of free speech and free association. To accept defeat in the matter of free speech and free association is to court disaster.. In the general interest therefore, we must defend these elementary rights with our lives No cost is too great for purchasing these fundamental rights. (Kanakkhana, 1971, "Gandhi Marg", 279 280).

Sarvodaya lays stress on the individual as the starting point of social regeneration Individuals gain importance and enjoy full freedom Gandhiji gives a warning when he says that "the highest form of freedom carries with it the greatest measure of discipline and humility. Freedom that comes from discipline and humility cannot be denied; unbridled licence is a sign of vulgarity injurious alike to self and one's neighbours". (Mohan Rao, The Message of Mahatma Gandhi, 81).

He adds: "I value individual freedom but you must not forget that man is essentially a social being. He has risen to his present status by learning to adjust his individualism to the requirements of social progress Unrestricted individualism is the law of the beast of the jungle We have learnt to strike the mean between individual freedom and social restraint. Willing submission to social restraint for the sake of the well-being of the whole society enriches both the individual and the society of which one is a member". (Mohan Rao, The Message of Mahatma Gandhi, 82). The Sarvodaya socio-economic order thus visualises an egalitarian society with limited wants, guaranteeing people bread with dignity and without loss of liberty. Even the poor, the lowly and the lost who are contemptuously treated by the present society would be equal to others in society, breathing the free and fresh air of freedom and enjoying a wholesome life of contentment.

Such an ideal society based on spiritualism calls for a revolutionary change in the outlook of the people. They are to-day selfish, materialistic and power-crazy with scant regard for the means They should become disciplined, unselfish and service-minded. This implies a leap from one extreme to another; to achieve a change of heart through appeals is not that easy. Therefore the Gandhian way may sound either Utopian or reactionary Gandhji thought otherwise. "In short the reactionary turn", he remarked, "if at all it was, meant a return to commonsense, meant restoration of what appears to commonsense to be a natural order as distinguished from the present unnatural order, in a word, not everything overturned or everything petrified but everything restored to its proper place" (J.S Mathur and A S Mathur, "Economic Thought of Mahatma Gandhi", 48) Let not the pessimists deter the well-meaning people from their earnest bid at ... . creating a brave new world, ushering in real freedom and prosperity, as epitomised by the great philosopher poet Thiruvalluvar in his words, "Blessed is the realm that knows no famine or pestilence and is free from agression".

References

1. Barbara Wootton 1970 : Freedom under Planning 9
2. D.H Robertson 1949 The Control of industry 87
3. K K. Dewett 1975 Modern Economic theory 1130
4. Gandhi Harijan 1946, August 4, 246
5. T K Mahadevan, 1971, Gandhi Marg, 58, 15, 214
6. V K.R.V. Rao 1970, The Gandhian alternative to Western Socialism 36-37
7. T.S Devadoss 1974 Sarvodaya and the Problems of Political sovereignty 273
8. Bharatan Kumarappa 1946 Capitalism, Socialism or Villagism? 28
9. K. Vasudevan 1967 Gandhian Economics 48
10. Kanakkhana 1971 Oct, Gandhi Marg, 59, 15, 279 80
11. U. S. Mohan Rao 1968 The Message of Mahatma Gandhi 81, 82.
12. J. S. Mathur and A.S. Mathur 1962 Economic Thought of Mahatma Gandhi 48

A STUDY ON THE LOCATIONAL CHARACTERISTICS DISTRIBUTION PATTERN AND TRADE AREAS OF WEEKLY MARKETS IN COIMBTORE DISTRICT - TAMIL NADU

E. SWAMINATHAN
Department of Geography, Madurai Kamaraj University, Madurai

The weekly markets play an important role in the exchange system of goods and services in the rural areas. The investigation aims to analyse the locational Characteristics, distribution pattern and trade areas of weekly markets in Coimbotore District of Tamilnadu. The study has clearly brought out the influence of river valleys and transport network on location. The over all distributiou pattern of weekly market is rondom due to relief and nodality. Eventhough some weekly markets declined new centres emerged more in number to carryout the marketing function. The gravity model employed to deltmit the trade areas has helped to identity the theoritical trade areas. The trade areas of weekly markets in the river valleys are smaller than others. This is due to the population density. The consumer and trader movement will be very much helpful in delimiting the trade areas and also the organizational system.

Introduction :

The weekly market system is fouud to occur in many developing countries of the world today. Generally these markets are found to associate more with the traditional agricultural sector rather than with the modern sector. However, the weekly markets are the important components of the internal exchange system Hence, scholars from various deciplines have attempted various theoritical and empirical aspects of the periodic market systems. Much work has been done pertaining to the size, location, periodicity, functions, hierarchy, synchronization in space and time and evolution (Stine 1962; Skinner 1964; Hodder 1965; Bromley 1971; 1974; Smith 1971; Good 1973; 1975; Symanski 1973; Symanski and Webber 1974; Riddel 1974; Swaminathan 1976).

The market place has three functions such as social, political and relegious apart from economic role (Bohannan and Bohannan, 1968). It is also an accepted fact that the market places have economic and non-economic functions. The commodities that are generally sold in these markets are perishables, non-perishables and durable goods which are mostly used by farmers. Since the weekly markets provide goods and services to the surrounding population they are called as 'Periodic Central Places' or 'Mobile Central Places'. It is because of the fact that these centres do not have threshold population to offer the goods and services that they require through permanent commercial establishments Only on a market day when people from surrounding areas collect at a centre form the threshould population to offer the goods and services. And thus the weekly markets continue to exist.

Weekly markets are a common feature in all parts of India right from the historical periods and more especially in commercially less developed areas. In these markets people congregate from a wider or a narrow area depending upon the importance of the particular market, which again is dependent on the sale of the transactions carried on. The place selected for a market naturally presents particular facilities for communication in several directions. In Tamil Nadu by about 18th Century there were a network of well established weekly markets. Such weekly markets are still found in Tamil Nadu and more especially in Coimbatore District.

The aim of the study is to analyse the growth/decline, locational characteristics, distribution pattern, population size of the weekly markets and market days of the weekly markets in Coimbatore District. Further an attempt is made to delienate the theoritical trade areas of the weekly markets in the study area using the gravity model.

Study area :

Coimbatore district comprises of nine taluks namely Bhavani, Gobichettipalayam, Erode, Dharapuram, Palladam, Avanashi, Coimbatore, Pollachi

and Udumalpet. The total area of this district is 15,673 Km². It is bordered by the Kerala State on the Southwest, Nilgiris on the North west, Mysore State on the North, Salem on the North-east, Trichirapalli on the East and Madurai in the South. This district is drained by Moyar, Bhavani, Noyyil and Amaravathy rivers. There are 143 weekly market in this district and their taluk-wise distribution is shown in the following table.

TABLE 1

Area and number of weekly markets in each taluk

S.No.	*Name of the Taluk*	*Area in Km^2*	*No. of weekly Markets*
1.	Bhavani	1428.54	13
2.	Gobichettipalayam	2923.13	14
3.	Erode	1552.55	40
4.	Dharapuram	2210 95	8
5.	Palladam	1515.17	23
6.	Avanashi	1277.49	13
7.	Coimbatore	1368.45	12
8.	Pollachi	1835 82	9
9.	Udumalpet	1437.09	11
		Total	143

There are more number of weekly markets in Erode and Palladam taluks of this district (Table I). In the case of Dharapuram there are only eight weekly market centres. The weekly markets in other taluks are almost equal in number. The number of weekly markets might have been influenced by physical, economical, social, and cultural reasons. But however it is noticed that except Erode and Palladam the other taluks show that there is a relationship between the area and the number of markets.

Decline and Growth of Weekly Markets

A careful perusal of the one inch toposheets revealed the fact that there were altogether 127 weekly markets in this district during nineteen twenties. Out of this 20 centres in course of time grown in size and attained urban status in 1971. Out of 127 centres only 45 centres continue to schedule the markets till to date and 62 centres have stopped scheduling these markets. It may be pointed out here that 110 villages which did not schedule these markets in 1920 now started scheduling the weekly markets. The decline and growth of weekly markets may be attributed to the changes that have taken place in the transport network and the locational preferences in terms of nodes Now there are 145 market centres in this district. The number of new weekly markets in various taluks in shown in the table 2 to get some idea about the taluks that have given rise to the development of new weekly markets.

TABLE 2

Showing the taluks and the number of new centres scheduling the weekly markets in 1971.

Taluk	Number of Existing centres	New Centres	Total
Erode	12	28	40
Bhavani	6	7	13
Gobichettipalayam	3	11	14
Dharapuram	2	6	8
Palladam	5	18	23
Avanashi	6	7	13
Coimbatore	8	14	14
Pollachi	3	6	9
Udumalpet	2	9	11
Total	45	110	145

Obviously, all the taluks have given rise to the development of new weekly markets (Table 2). However, it is quite significant in the case of Erode, Palladam and Gobichettipalayym taluks. The development of new weekly markets in these taluks may be attributed to factors such as the development of transport network, efficient transport system, production of surplus commodities, demand, social change etc,

Locational Characteristics of Weekly Markets

Generally it is an observed fact that the location of the weekly markets are governed by physical and cultural elements. The transport network which provides easy accessibility in all directions influences the location of weekly markets.

If we look into the map (Fig. 1) it is found that the weekly markets in this district has been favoured in their origin and growth by rivers and

roads. They have acted as a dominant control over the location of weekly markets. It may safely be concluded that the river valleys would have favoured the origin and growth of weekly markets by providing irrigational facilities to produce surplus and easy access for travel. Subsequently the development of good road network have influenced the origin and growth of these markets in the later period. The map very clearly shows that more than two thirds of the weekly markets in this district are located along major roads and the rest on minor roads.

By inspection it is found that a greater concentration of the weekly markets along the Noyyil and Bhavani river basins than other areas. A very high concentration of these markets are found in Erode and Palladam taluks. Whereas the sparse distribution is found in the northern, southern western and south eastern parts. Even among high concentration in the river basins, it is more in the case of Noyyil river basin.

After the analysis of the locational characteristics of the weekly markets it is found that they are found mostly in the zones where the plain encounters with hilly tract. This phenamenon is very clearly seen in the western, northern and southern part of this district. Likewise the weekly markets are located in the meeting places of wet and dry tracts. These two locational characteristics brings out the fact that the need for an exchange of commodities between the people in two different environment. To facilitate their exchange of commodities weekly markets emerged in such meeting places. Of course the other locational characteristic is the nodality of the transport network. These are some of the important locational characteristics associated with the development of weekly markets in this district.

Distribution Pattern of Weekly Markets

The nearest neighbour technique is employed to quantity the distribution pattern of weekly markets in this district. The Rn value computed for the 143 weekly markets in the district is 1 26 It suggests that the distribution pattern is random. This might be due to influence of loca ional factors such as relief, nodality etc , To see whether there is any difference in the distribution pattern of the weekly markets within different taluks, Rn value was computed for all taluks and it is tabulated below.

TABLE 3

Showing the Names of the Taluks and Rn. Values

Name of the Taluk.	Rn. Value
Bhavani	0 98
Gobichettipalayam	0 56
Erode	1.09
Dharapuram	1 26
Palladam	1 23
Avanashi	1.32
Coimbatore	0 92
Pollachi	1 14
Udumalpet	0 90

Table 3 shows that the distribution pattern of weekly markets in different taluks vary from clustered to random pattern. The weekly markets in Gobichettipalayam exhibits a moderate concentration pattern. Almost uniform pattern of distribution is fonnd in Bhavani, Coimbatore and Udumalpet taluks. Dharmapuram, Palladam, Avanashi and Pollachi indicate random distribution patteтn. Erode taluk exhibits almost uniform pattern The random pattern of the weekly markets in most of the taluks might be due to the influence of physiography and transport network. If we look into the average interdistance between the weekly markets in this district, it is only only 5.8Km. This suggests the fact that it may be the most ideal distance the people could travel to and fro to a weekly market to buy or to sell the goods and services in a day with the available transport facilities. This may also due to the fact that a greater proportion of the famersr and traders cover this distance by foot. Therefore, interdistance and the distribution pattern might have been decided by this distance factor in the past that exists even today.

Population size of the weekly markets

If we agree that the weekly market centres do not have the threshold population to provide goods and services through permanent establishments than the question arises whether the weekly markets are a characteristic feature of small villages. To answer this question the population size of the weekly markets are analysed. From

the analysis it is found that the weekly markets centres population size vary from 500 to 18,000 (Fig. 2) In this connection it may be pointed out that Punjai Palatholuva an uninhabited village in Erode also has a weekly market. For a better understanding of the population size of the weekly market centres the villages have been divided into a number of classes namely very small, small, medium, large, very large and exceptionally large villages. The number of weekly market centres that fall in different classes and their respective population size is given in table 4.

TABLE 4

Population Size of the Weekly Market Centres and the Weekly Market Centres in Each Class

Nature of the villages that schedule the weekly market	Population size of the villages	Frequency
Uninhabited	Nil	1
Very small	Less than 1000	6
Small	1000 2500	27
Medium	2500 – 5000	50
Large	5000 – 7500	38
Very large	7500 – 10,000	11
Exceptionally large	Above 10,000	10

It is found that a greater proportion of the weekly markets are held in medium size villages (Table 4). About 27% of the weekly markets are scheduled in large villages. 19% of the weekly markets are held in small villages. About 21 markets are scheduled in very large and exceptionally large villages of which the laters population is more than 10,000, From this it may be concluded that the villages whose population size between 2500-5000 is more predominent. However, 2/3 of the weekly markets in this district are scheduled in villages where population ranges from 1,000 to 7,500. The weekly markets centres of less than 1000 population are not significant in the district From this it may be inferred that these villages (population between 1000 to 7,500) have not developed any permanent marketing facilities. In the case of villages with more than 10,000 population have some permanent retail structure. However the weekly markets are scheduled in these centres as a matter of tradition

Marketing Day of weekly markets :

The weekly markets ara held in all days of the week. However, it is found that the predominant market day vary from taulk to taulk. For instance Sunday market is prominent in Bhavani, Gobichettypalayam, Avanashi and Palladam taluks (ie more number of markets are held in this day of the week in these taluks than other days.) Besides, Saturday market is also prominent in Palladam Taluk In Erode taluk 25% of the markets are conducted on Thursday. In Bhavani taluk no weekly market is held on Friday. In the case of Dharapuram and Palladam taluks no weekly market is conducted on Monday and Tuesday. In Pollachi taluk Wednesday and Thursday are marketless days On Thursday no market is held in Gobichettipalayam and Udumalpet taluks. On the contrary in Avanashi, Coimbatore and Erode taluks the weekly markets are held in all days of the week. This market days and marketless days fixed may be due to social or cultural reasons or might be due to the fact that the farmers and traders will feel it convenient to visit different markets in different days to fulfil their needs. On the whole a large number of markets are held on Sundays and Saturdays. To some extent Wednesday, Thursday and Friday market days are also important. The Monday and Tuesday markets are few and less important in this district.

Theoritical Trade Areas of weekly Markets in Coimbatore District :

Since the weekly markets provide goods and services to the surrounding areas they are called as 'mobile central places'. The farmer/trader finds the threshold population only where there is a periodicity of the market where people from a wider area congregate to provide the threshold population. Thus the weekly markets attract farmers/traders from different places to come and offer / buy goods services This in turn depends upon the population and their demand. This population and their demand gives rise to the variation in the type and number of functions offered in these weekly markets. This ultimately influences the size of the trade area and the population served. The centres with more population will have more functions and

serve large area and more population. On the contrary centres with less population offer less functions to a lesser area and population. The actual trade areas of different weekly markets can be delimited on the basis of consumer travel pattern. However, in the absence of primary data on consumer travel pattern the theoritical trade areas can be delimited using the 'Gravity Model'. Since this model was used in the earlier research works to demarcate the trade areas or service areas. The gravity model assumes that centres with more population serve large areas than less population centres. This inturn is dependent upon the intervening distances. Based on this criteria the theoritical trade areas of 143 weekly market centres in Coimbatore district is delienated. The formula employed is as follows.

$$BP = \frac{Dist}{H\sqrt{\frac{WM_1}{WM_2}}}$$

Where BP is the break point in between two weekly markets

Dist. is the distances seperation the weekly markets

WM_1, WM_2 Population size of Weekly markets 1 and 2

By applying this equation one can estimate the location of boundary line between the market area of two weekly markets.

At the outset the interdistance between one weekly market centre and its surrounding markets were measured in the map. Then the equation was applied and the break points between two markets calculated. This is carried out for all the 143 weekly market centres in this district. Based on the break point the theoritical trade areas are demarcated. This has resulted in different size of the trade areas as per their population and intervening distance (Fig. 3).

From figure-3 it is clearly seen that the trade areas of the weekly markets in the river basins generally have smaller trade areas when compared to the markets on the perepheral areas. Secondly market centres with more population are found to serve large areas than centres of less population. Further it is noticed that weekly markets in drier tracts serve more area for their population due to less density of population. There are a few markets whose trade areas are comparitively larger than expected. The trade areas of the weekly markets are influenced by population distribution, density and so on.

Conclusion

The study has clearly brought out the fact that there is a relationship between the area of the taluk and the number of weekly markets. The location of the weekly markets are influenced by the phvsiography and transport network. The number of new weekly markets that emerged in the recent years are found mostly in areas where the hiliy tract meet with the plain or the dry tract meet with a wet tract. The river valleys also favoured the orign and growth of weekly markets. The market day of the weekly markets are soly due to the social and cultural practices of the people The weekly markets exhibit a random distribution pattern. Even though the trade areas are delimited theoritically, still it is felt that consumer preference to these markets will be more appropriate way to delimit the same. The trade areas are influenced by the density of population and physiography than other factors.

References

Bohannan P. and L. Bohnnan, ('968) "Tiv Economy", Evanston, North Western University Press.

Bromley, R. J (1971) "Markets in the developing countries : A Review", Geography, 56, 124-132.

Bromley, R J. (1974) "Periodic Markets, Daily markets and Fairs : Bibliography", Melbourne, Monash Publication in Geography.

Good, C. M. (1973) "Markets in Africa : A review of research themes and the question of market origins", Cashiers d' Etudes Africares, 13, 769-780.

Good, C. M. (1975) "Periodic Markets and travelling traders in Uganda", Geographica Review, 45, 49-72.

Hodder, B. W. (1965) "Distribution of markets in Yorubaland", Gotish Geographical Magazine, 81, 48-58.

Riddel, J. B. (1974) "Periodic Markets in Gierra Leone", A.A.A.G., 64, 541-548.

Skinner, G. W. (1964) "Marketing and Social structure in Rural China", Journal of Asian Studies, 24, 3 - 43.

Smith, R. H. T. (1971) "The theory of periodic markets: Consumer and trader behaviour. Canadian Association of Geographers, 183-189.

Stine, J. H. (1962) "Temporal aspects of tertiary production elements in Kolea", 68-38 in F. R. Pitts (ed) Urban systems and Economic Development Eugene, University of Oregon, School of Business Administration.

Swaminathan, E. (1976) "Market Centres and Consumer preference within Coimbatore Metropolitan Area", Ph. D. Thesis (unpublished), University of Madras.

Symanski, R. (1973) "God, Food and Cousumers in periodio Market Systems", A. A. A. G. 5, 262-265.

Symanski, R. and W. J. Webber (1974) "Complex periodic Market Cycles", A. A. A. G., 64, 303-312.

PRE-AND POST-NATAL CARE AMONG SLUM MOTHERS

G. MANI
Department of Sociology, P.M. Thevar College,
Usilampatti-626532, Madurai District, Tamil Nadu.

ABSTRACT

The investigation attempts to explore the possible social pressures causing poor pre-natal care, infant mortality, and abortion among slum mothers. 100 married women were interviewed for the study and the data indicate that the poverty environment and lower socio-economic status are the main factors for poor-pre - and post-natal care. It also shows that the large the size of the family the greater the number of infant deaths, and shorter the spacing the higher the instances of infant mortality. Further, it also brings out the fact that poor medical care, repeated pregnancy, and vulnerability to stress due to family conflicts, fear of insecurity, and depression and frustration casued by poverty are the main causative factors for abortion among slum mothers.

Pregnancy is a period of crisis, involving profound physiological and psychological changes. From early times it has been widely believed that the mother's thoughts or experiences may directly influence the unborn child. No doubt if they are serious enough to impair the mother's physiological state, the child's general development may suffer (Encyclopeadia Britannica, P-504). The state of pregnancy involves some changes and hence their effects on the attitude of a mother towards her child, are all the more significant, and she is under the full impact of this new experience, and hence could probably need some help and attention (Moses, 1972). As pointed out by Sobani (1948-49), health of the baby depends on the health of the mother. He further comments that the diet of the pregnant woman should be well-balanced; she should have fresh air, sunshine, exercise and relaxation. Further, emotions and nervous tensions have a very great idfluence on the composition and quantity of human milk. Therefore the mother should be serene, poised, so that she does not react intensely to the petty frictions of life during the period of pregnancy. In reality the contrary is true. It will be interesting to know how these factors operate among expectant mothers in slum situation.

Objective of the study :

The present paper endeavours to scrutinise the family circumstances of the slum mothers with a view to estimating possible pressures causing poor pre-natal and post-natal care, poor medical treatment, infant mortality, or abortion. So the major objective of this paper is to explore the causative role of social background of slum mothers on the problem.

Methodology :

The primary data for this paper were drawn from the author's previous first hand study on "Child Rearing Practices in a Slum in Madras City". The total sample comprises of 100 married women (Age Group = 16 – 45) of Anna Nagar Slum in the City of Madras. The sample was selected at Random. Our study covered 35% of the total population of married women (N = 286) who had atleast a child living during the period of investigation (1975-76). Data were collected through personal interviews with the respondents at the time of the original study.

Main Findings and Discussion :

Social background of Slum Mothers: Out of 100 women in our sample, 78 are Harijans. Early marriages are common in this slum. Usually slum girls get married in their early teens and the boys at their early twenties. Consequences of these are early motherhood and increased family size. It is observed that the respondents of this study (i. e. slum mothers) have large-sized families. In some of their families ten or eleven persons live together with a single bread-winner. A typical household size is 6. 63% of slum mothers belong to nuclear families while 29% of them are in joint

families. 73% of their families are not getting a stable income as the bread-winners are casual labourers. The average monthly income of the household comes around Rs. 195/-. None of them saves money for his future and 97% of them reported that they are in debt. Almost all slum mothers are illiterates.

Pre-Natal Care : The study of Swain (1978) in in Orissa has indicated that pregnancy is considered to be a very happy incident in the family, is well accepted and receives special attention. She further states that a lot of "dos" and "don'ts" are prescribed during the pre-natal period to make the girl happy. As pointed out by Sicault (1963), during the whole pre-natal period and at the time of delivery importance should be given to the health of the expectant mother. Contrary to these findings, our study shows that expectant mothers is slum do not observe any "dos" and "don'ts" and do not seek medical treatment during their pregnancy, unless they are faced with some difficulties. They prefer free treatment in Government Hospitals, that too only when they have problems like digestion problems, giddiness, dysentry, gastric troubles and the like during pregnancy. They are indifferent to periodical medical check-up. Their poverty or miseries in their family life make them to feel that they cannot afford to follow the doctor's advice. Even when the necessity of periodical testings is explained, they feel that these are unwanted and unnecessary.

Our data showed that most of the mothers (45%) go to the Government Hospitals for confinement only. No mother goes for post-natal care Only 38% of them go for pre-natal care which is usually followed by confinement in the hospitals. It is evidently shown that 17% of them do not take any treatment if they have problems owing to their ignorance, and sometimes they prefer only home remedy. Mothers who prefer hospitals only for their confinement reported the following important reasons for their choice :

a) There are no proper facilities in their houses for delivery ;

b) The fear of incurring unexpected expenses during the time of delivery in their houses; and

c) Their houses being single-roomed and over-croweded causes inconvenience for the rest of the members of the household.

Post-Natal Care : A mother will remain in bed only for three days at the time of confinement. As reported, she will return to her hut on the fourth day and start doing all her routine household chores. But in joint families the situation is different. Mothers reported that the other women in the joint family will take care of the household activities. Any way it does not mean here that the new born baby is taken care of by every body in the house and the mother is given rest from domestic work to take care of the baby. Doing all kinds of works by the slum mothers immediately after confinement is detrimental to their health. This affects the health of the new born infants also.

Usually infants are placed upon the clothes on the mud floors. In some houses we were able to find the infants on the mud floors even without clothes. There is no protection against insects and other health hazards. It is contrary to the view expressed by Kandekar and Joshi (1973) that in addition to the adequate level of nutrition, protection from helth hazards is very important to a child in his development. In support of this view Sicault (1963) also concluded that during the early infancy health protection is most important. If the mother is busy with some chores, the baby has to wait till she finishes her work even if the bady cries. She will not leave the work and give attention to her baby. If it is an unwanted child, there is no question of the child receiving any care But in joint families the crying baby is picked up by any other female member.

Regularity in feeding and care of the baby is very much needed for healthy childhood (Sobani, 1948-49). However these are absent among the slum dwellers under study. Breast-feeding is very common in slums. If a slum mother lacks breast milk, cow's or baffalo's milk is substituted. Tea is given to the infants in some families. Majority of the infants are breast-fed for a period of six months. In 57% of the families babies suffer from lack of mother's milk, whereas in 33% of the families they are sufficiently fed with mother's milk. But on the

other hand, in 10% of the families babies have never tasted the mothers milk. Out of them, the important ones are as follows : lack of secretion of milk a) due to successive pregnancy; b) due to malnutrition; and c) due to illness of the mother.

As Sicault (1963) pointed out that although the causes of malnutrition are complex and inter-related, poverty is undoubtedly the main cause. Further, as he indicated in his study, malnutrition - a polite word for semi-starvation-leads to the attack of diseases. So it is needless to say that during the period of early infancy protection of mother's health is most important which may be unknown to slum dwellers.

Illness of the mother, failure of breast milk, and successive pregnancy are the most common factors for weaning of the baby in slum. Slum mothers reported that they will try to wean only if it is found necessary. Somehow or other slum mothers managed to give supplementary milk along with some solid food before weaning is started. We could not find any evidence for the post-partum sex taboo on sex relation among slum people during this period of early infancy of the child.

Infant Mortality : Infant mortality is a sensitive index of child health in the community (UNICEF Report, 1963). It is very obvious that one of the most serious consequences of poverty in slums is 'Infant Mortality'. During the period of our investigation, we observed the following : i) 4 still-borns, ii) 6 neonatal deaths, and iii) 34 infant deaths. The following Table (Table-1) gives a picture of the relationship between the size of the family and infant mortality.

TABLE-1

Family Size and Infant Mortality

Family Size	Frequency distribution of instances of Infant Mortality.	%
Small (Less than 4 members)	4	11 77
Medium (5-6 members)	13	38.23
Large (More than 7 members)	17	50 00
Total :	34	100.00

Eventhough the Table (Table-1) shows the positive relationship between the family size and the number of infant deaths, it needs further investigation. The health of both mothers and children is more likely to be maintained with fewer pregnancies and children (Bhatia and Alfred, 1973), whereas in slums repeated pregnancy and lower birth-interval (spacing) are very common. It seems that the 'idea of spacing' is completely ignored by slum people. A slum mother becomes pregnant when her former child is hardly a year old. This is also another reason for occurrence of infant mortality in slums. The following Table (Table-2) shows the relationship between the birth-interval and infant mortality in slum familes.

TABLE-2

Birth-Interval and Infant Mortality

Birth-Interval (in completed years)	Frequency distribution of instances of Infant Mortality	%
1 year	17	50.00
2 years	11	32 35
3 or more years	6	17.65
Total :	34	100 00

The Table (Table-2) shows that the occurrence of infant mortality is inversely proportionate to the birth-interval. Eventhough it yields the fact that the shorter the birth-interval the higher the instances of infant mortality, it needs further investigation and verification.

Chandrasekhar (1972) concludes, "It seems reasonable to assume that Family Planning resulting in fewer children per family, who would receive better care, will lead to less infant mortality; and the lower infant mortality rate will lead to the evolution of the small family" Although the Family planning became an official programme of the government, it may be stated that very little was achieved by way of results in motivating people to accept the small family norm among slum dwellers. It is observed that slum people have indifferent attitude towards Family planning as they feel that it is unwanted and unnecessary.

Abortion : Abortion is not merely a physical phenomenon, but is very much influenced by

mental, economic, and social conditions of the women, her family, and cultural values (Mahajan, 1976). Induced abortion is a very common means to get rid of unwanted pregnancy for a slum mother. During the period of investigation, it is reported that inspite of the provision of facilities in all Government Hospitals for termination of pregnancy, most of the abortions in the slum are performed by unqualified practitioners especially by indigenous medical practitioners under most unhygienic conditions. The findings fall in line with the earlier researchers like Bhatia (1973) who found that in India, particularly in rural areas, a large number of abortions are being performed by unqualified medical practitioners under most unhygienic conditions. This findings can be well matched with the cases of slum mothers who are migrants from rural areas. Mahajan (1976) pointed out that economic condition of the family, the health of the mother, improper spacing, or small size of the family - all these may be some of the reasons for abortion seekers. But in slums the condition is quite different. The findings among slum mothers confirm the findings of Bhatia (1973) who found that due to some of the socio-economic, psychological, and situational factors, the women prefer to terminate their unwanted pregnancies.

As mentioned in 'The Abortion Report' (1974), most women who became unwantedly pregnant suffer from the mental disturbance caused by family conflicts, strained marital relations, frequent quarells, repeated pregnancy, fear of insecurity, depression and frustration due to poor socio-economic status in slum culture. As reported by slum mothers, all these factors in slums exert a strong social pressures for abortion for women who do not want to continue the pregnancy. Most of our respondents came out with their personal problems and expressed their frustration in family life due to family conflicts, strained marital relations, and frequent quarells. It is also reported that a pregnant woman who seeks abortion will try it by herself first, to avoid going to a practitioner. People conceal this fact for the reasons best known to them. Bhatia and Alfred (1973) found that abortion seekers usually go for overdoses of "pilladone", "quinine", or "ergot tablets", and in some cases, they go for using indigenous preparations in addition to the above drugs, whereas in slums abortion seekers prefer only indigenous preparations. Slum mother seeks the help of practitioners, who are quite popular among those who seek abortions, only when she has failed in her attempts. This often happens at an advanced stage of pregnancy. The findings of Shantilal Shah Committee (1966) are also similar to that of ours. According to Shah Committee, the practice of abortion in India is widespread but is done secretly. Approximately 65 lakh abortions take place every year in India. Out of these 39 lakh are induced abortions and a majority of them is done under unhygeinic conditions by people who do not possess any professional skill.

In most cases, as reported by slum mothers, abortion seems to take place among slum mothers without any inducement. Most of the women reported that they do not know the reasons for abortion in their own cases. Martin (1974) very strongly emphasized that postabortum family planning care is the most important one for the welfare of the mother. But this aspect is completely neglected by slum people. Lack of nutrition, poor health due to repeated pregnancy may be the reasons for natural abortion among slum mothers. 12 cases of abortion were reported during the period of investigation. Among them two third (8 cases) were natural abortions as reported by the slum mothers. Generally it is found that the majority (58.30%) of the incidence of abortion takes place in families where birth-interval is one year and less, i. e, where repeated pregnancy is observed. Though this yields the fact that repeated pregnancy among slum mothers coupled with their poverty is a strong reason for abortion it needs further investigation and verification.

Conclusion :

On the whole the findings of this study bring out the following facts : Pre-natal care of the mother and Post-natal care for both the child and mother are totally inadequate in this slum. Repeated pregnancies are very common among slum mothers. They do not get proper food and adequate rest. Slum dwellers do not make any attempt to control the size of the family, though they feel that a large family is a burden to support. The occurrence of *Infant Mortality* is very common in this slum. Poor medical care, repeated pregnancy, vulnerability to stress and frustration caused by poverty are the main causative factors for abortion among slum mothers.

Acknowledgements

The author is indebted to Dr. C. M. Abraham, Professor and Head, Department of Sociology, University of Madras Autonomous Post-Graduate Centre, Coimbatore, for his guidance in conducting this study.

The author is also highly thankful to Dr. R. Venkataratnam, Professor and Head, Department of Sociology, Madurai Kamaraj University, Madurai, for going through the manuscript and making valuable suggestions.

The author's hearty thanks are also due to Mr. K. Bose, Principal, P.M. Thevar College, Usilampatti, for having extended all co-operation and necessary help to the author in completing this paper.

References

1) "Abortion Report" (para-149), 1974. Political Quarterly. Vol. 45, No. 3, (July-September).

2) Bhatia, J. C. 1973: "Abortionists and Abortion Seekers" The Indian Journal of Social Work, Vol. XXXIV, No. 3, (October), P. 275.

3) Bhatia, J. C. and K. Neumann Alfred 1973: "Practi tioners of Indigenous Medicine and India's Family Planning Programme", The Indian Journal of Social Work, Vol. XXXIV, No. 1, (April), pp. 32-33.

4) Chandrasekhar, S. 1972: Infant Mortality, Population Growth and Family Planning in India, London: George Allen and Unwin Ltd., p. 263.

5) Chilman, S. Catherine n.d.: "Growing Up Poor", Washington: U. S. Department of Health Education and Welfare, p. 34.

6) Encyclopeadia Britennica, Vol. 5, Chap: Child Psychology, p. 504.

7) Khandekar, Mandakini, and Pratiba Joshi 1973 "Assessing Nutritional Status of Pre-school Children: Some organizational Considerations", The Indian Journal of Social Work, Vol. XXXIV, No. 1, (April), p. 11,

8) Mahajan, A 1976: "Social implications of Legalization of Abortion", The Indian Journal of Social Work, Vol. XXXVII, No. 1, (April), p. 31.

9) Martin, J F. 1974: "South-East Asia: Methods in Postpartum Family Planning", The Journal of Family Welfare, Vol. XX, No. 3, (March), p. 15.

10) Moses, Mabel Benzion; 1972: "First Pregnancy-Implications for case work", The Indian Journal of Social Work, Vol. XXXIII, No. 3, (October), p. 269.

11) Shantilal Shah Committee 1966: Report of the Committee to study the question of Legalization of Abortion, Department of Family Planning, Ministry of Health and Family Planning, (Government of India), New Delhi

12) Sicault, (Ed.) 1963: The Needs of Children.UNICEF, New York: Free Press of Glencoe, pp. 56-57.

13) Sobani, H.Y Z 1948-49: "Breast-Feeding Conditions amongst Indian Mothers", The Indian Journal of Social Work, Vol. IX, pp. 185-186.

14) Swain, Saraswati. 1978: Customs and Beliefs associated with Pregnancy and Child Birth in Rural Orissa", The Indian Journal of Social Work, Vol - XXXIX No.1, (April). pp. 79-82.

15) Children of Developing Countries - UNICEF Report 1963 - Cleveland and New York: The World Publishing Company.

16) Whiting, B. B. 1963: Six Cultures: Studies of Child Rearing, New York: John Wiley and Sons Inc.

A CRITICAL NOTE ON THE WAY TO ATTAIN THE GOAL OF LIFE IN THE SĀṀKHYA AND THE YOGA PHILOSOPHIES

P. K. SASIDHARAN,
Lecturer in Sanskrit, Madurai Kamaraj University, Madurai-2.

SYNOPSIS

Among all the systems of Indian Philosophy the Yoga of Patanjali and the **Sāṁkhya** *of Kapila are related in many aspects. As for as on the way to attain the Goal of Life in the both philosophies are concerned, the saying "If the* **Sāṁkhya** *is the theory the Yoga is its Practical side" is apt. The article analysis the problem.*

Yoga is the most widely known and popularly appreciated system of thought and is attributed to Patanjali. According to epic the Yoga system which is ancient like the *Sāṁkhya.*

Tradition holds that he was a great Seer and his date is assigned to the 2nd century B.C. *The Yoga sūtras* are commented on by the eminent modern Scholars as well as the traditional scholars like Vyāsa, Vācaspati Miśtra and Bhoja. Historically the Yoga system is complementary to the *Sāṁkhya.* It is generally accepted that if the *Sāṁkhya* system is a theory, the Yoga is the practical side of it. Keith observes that in the epic the relation of the *Sāṁkhya* and the Yoga is precisely as in the *Upaniṣads,* the two stand side by side as philosophy and religion as theory and practice.

In the *Sāṁkhya* system there is no reference to God or *Īśvara.* The meditation is upon the eternal truth of the puruṣa being different from the *prakṛti.* When it is attained, all operations in the internal organs of the body is suspended and the *puruṣa* returns to itself the disciple becomes *jīvanmukta* or liberated soul. He remains free from passions and feelings of pain and pleasure. He is virtually divorced from *prakṛti* Patanjali postulates the existence of a God over and above that of the *puruṣas.* He is perfect and serves as a pattern for worship.

The *Yoga* view of the goal of life means a long course of discipline to attain the knowledge which gives liberation. The discipline which is referred to in the Yoga is briefly dealt with in the *Sāṁkhya* system where the goal of life is *Kaivalya* or *mokṣa* which itself is liberation. By practising faithfully various parts of *Yoga,* impurities are removed and power of perception is achieved through enlightenment.

Yogāṅgānuṣṭāinuśṭānādas'udhikṣaye
juānādīptirāvivekakhyateḥ
(*Yoga Sūtra.* 81)

Eight parts of the Yoga

" Yamaniyamāsanaprāṇāyāma -
Pratyāhāradhāranādharānadhyāna -
Samādhayoṣṭāvaṅgāni "
(*Yoga Sūtra.* 80)

Yama (Good conduct)

The first step in the *Yoga* gives the right direction to our will and represents the attainment of the good as distinguished from the truth. It helps to cultivate friendliness, and compassion. It helps also one not to be irritated by others virtues and sympathise with one in his distress.

" Ahimsāsatyāsteyā brahmacaryāparigraha
yamāḥ (*Yoga Sūtra 81*)

Good conduct comprises (1) Non-violence (2) Truth (3) Honesty (4) Control of sexual desires (5) unattachment.

It is very necessary for the yogin to control the mind by cultivating the above mentioned habits.

Niyama (Certain rules)

Cleanliness of the body and the mind, contentment of personal desires practice (hard and persistent) acquiring knowledge by study, personal contact etc., and self surrender to God.

"S'aucasamtoṣatapaḥ suādhāyes'varapraṇidhānāni niyamaḥ

(*Yoya Sūtra. 81)*

It is on this pre eminently moral foundation that any spiritual training rest. Without such foundation there is no possibility of salvation.

Āsanas (Some physical postures)

Sitting posture which is suitable for meditation also give, comfort and stability.

"Sthirasukhamāsanam"

(*Yogr Sūtra. 97*)

It is intended to secure control of the physical frame with a view to help the control of the mind. This posture enables the *yogi* to absolutely still for a long time.. Patanjali advocates for this purpose the practice of *Prāṇāyāma* or breath control.

Pranāyāma (Breath control)

Yoga sutra recommends the practice of controlled breathing with the ultimate object of suspending it for as long period as possible. The respiratory exercise strengthens the heart., but this must be done under expert guidance. At the time when mind is free from the process of thought rythm of breathing is automatically regulated to the point of disappearance and the very life force is tranquilised.

"Tasmin Sati S'vāsapras'vāsayoger gativitebedaḥ prāṇāyāmah"

Yoga Sūtra 100

It is interesting to note that austerities (Tapas) play a very small part in the *Yogasūtra* since the tapas is regarded as a form of Yoga.

pratyāhāra (Unattachment to the pleasures of five senses) When five sense organs of the body are not engaged in their own field of activity and the mind, instead of associating with anything identifies itself with its own consciousness, then that is the stage of unattachment of five organs.

Svaviṣayāsamprayoge cittasvarupānukāra ivendriyāṇām Pratyāhāraḥ

(*Yoga Sūtra* 105)

The senses are assailing the soul through the operations of the intellect and unless the mind withdraws from the senses, or unless the senses are otherwise rendered irroperative the disturbance to the soul will continue. The *Yoga* system does not recommend the plucking out of any organ. Hence withholding the senses from the object is necessary to pave way for attaining salvation.

Dhāraṇa (Concentration of mind)

Des'abandhascittasya dhāranā

Yoga sūtra 107.

Concentration is fixation or focussing of mind on any one object or thought.

Dhyāna (Meditation)

Continuation of concentration is meditation.

Tatra pratyaikatānatā dhyānam

(*Yoga Sūtra 108*)

In this stage, the flow of thought on the subject must be steadfast without any break.

Samādhi (Tranquil and Superconscious state of mind).

Samadhi is the final step in the Yoga.

"Tadevārthamātranisbhasam
Svasupas'ūnyamiva Samādhi"

(*Yoga sūtra 109*)

As in the *Sāmkhya* the *Yoga* advise, non-attachment to everything seen or heard, resulting in self-control in detachment or renunciation.

Dṛṣṭānus' ravikaviṣayavitṛṣṇasya -
Vas'kāra samyñā vairagnyam

(*Yoga sūtra 15*)

How does this vairagya form in one's life? It is just as a man who have a wife beloved, delightful and charming from whom he could not bear to be separated even for a moment and on whom he excessively loved. If he then were to see that woman sitting in company with another man joking and talking he would be angry and displeased. Subsequently he were to discover that she had been guilty of a fault he would lose all desire for her and no longer looks on her as "mine". That is the *Vairāgya* which helps the *Yogin* to attain *Samādhi.*

In the *Sāmkhya* also concentration of mind is an absolute necessity to attain knowledge which in turn leads to liberation. In the *Yoga* patanjali advites the eightfold-path said above as a way to attain the concentration of mind which is turn helps one to attain his goal of life i.e. liberation. It is clear as far as this aspect is concerned the *Sāmkhya* is a theory where as the *Yoga* is its practical side.

Bibliography

1. Brahmottaramala of S'anakara mistra Ed. with English traslation. Dr. P. K. Sasidharan, Annals of oriental Research. Madras University, Madras-1971.

2. The Essentials of Indian Philosophy M. Hiriyanna, Allen and Unwin, London Ed, 1969.

3. History of Indian Philosophy, A. S. Das Gupta, Cambridge University Press, Cambridge, Vol. I & II Ed. 1963

4. Das' opanised. Chowkamba Sanskrit Series, Delhi

5. Philosophical foundations of India These Bernard, Rides & Co., London Ed. 1945.

6. Sā*m*khya Kārikā. (SK.) Ed. Suryanarana Sastry, Madras University, Madras. Ed. 1935.

7. Sā*m*khya. Pravacana Bhāsyā (SBB) Vijnānābhiksu (V.B.) Garbe, Leipzing. Ed. 1889.

8. Sā*m*khya System. A.B. Keith, YMCA Publishing House, Calcutta, Ed. 1949.

9. Six systems of Indian Philosophy. Maxmuller, Longmans Green, Varaṇasi & Co., Ed. 1971.

10. Tattva Kaumudī (TK) Vacaspati Mishra (VM) Edited by Jha. Oriented Book Agency, Poona, Ed. 1965.

11. Theism of Pre-classical Sā*m*khya. Dr. Ramakrishna Rao, University of Mysore, Mysore, Ed. 1966.

12. Yoga Sūtra with Vyasas Commentary. Ed. Ramaprasada. Sacred Books of the Hindus, Allahabad.

13. Study of the Sā*m*khya Kārikā with special reference to Sā*m*khyataruvasanta. Dr. P. K. Sasidharan, Madurai Kamaraj Univereity, 1981.

14. Concept of purusa in the Sā*m*khya philosophy, Dr. P.K. Sasidharan, Annals of Oriental Research, Madras University.

15. Gunas and their contradictory traits in Sā*m*khya Dr. P.K. Sasidharan, Madras University Journal, 1977.

16. Mudumbi Narasimhacarya. Dr. P.K. Sasidharan, Madras University Journal, 1977.

17. Prakṛti puruṣa siddhāntam Dr. P. K. Sasidharan, Visalakeralam, Bombay, 1976.

18. Puruṣārtha jñānamidam. Dr. P. K. Sasidharan, Visalakerlam Bombay, 1976.

19. Karma and Rebirth Dr. P. K. Saisdharan, Madurdi Kamaraj University Journal, 1980.

20. Concept of Prakṛti in the Sā*m*khya system. Dr. P.K. Sasidharan, Samakrta Vimara's Rastriya Samskrta Samstan, New, Delhi, Vol. V Decem. 1977.

21. Mudumbi Narasimhācarya's Commentary on Sā*m*khya Kārikā Dr. P.K. Sasidharan, Summary of Papers AIOC. Ujjain. 1971.

22. Kālidusa's treatment of the Moonin the Raghuva*m*s's Dr. P. K. Sasidharan, Madurai Malayalam Samajam 1980.

23. Problems in the relationship of the Spirit and matter with special reference to the Sā*m*khya Kārikā of īśvarakṛṣṇa. Madurai Kamaraj University Journal, 1980.

PETER PANDIA

By

K. GOWRI

Professor of History, A. P. A. Women's College, Palni

ABSTRACT

Peter Pandia, Collector of Madurai, was one of the best administrators during the rule of the English East India Company. He won the hearts of the people by his timely aid to the people when a grave epidemic ravaged the region with great fury. He was instrumental in introducing the ryotwari system in Madurai. The temple festivals of the Hindus received his rapt attention. He committed suicide as he feared that a treasury defalcation amounting to a few lakhs would be discovered. People remembered him, however, as a loveable administrator and praised him for his services.

The English East India Company produced a number of benevolent and efficient administrators whom the people of India held in high esteem. ROUS PETER who was the collector bf Madurai district from 1811-1828[1] was one such to be ranked along with the Englirh district administrators like Colonel Munro, George Campbell, Place and Lushington. Just as Lord Ripon earned the title 'Ripon Engal Appan'. meaning Ripon is our father, Rous Peter won, the affectionate title, "Peter Pandia" from the people for his benevolent reforms and great service to the people. In introducing administrative reforms especially the ryotwari system of land revenue in Madurai district he evinced no less zeal than Colonel Munro in the Ceded districts. He endeared himself to the people of Madurai by his warm sentiments towards the Hindus and their temple festivals. He is the best remembered of all the collectors of Madurai during the Company's rule as evidenced by the existence of many a Tamil ballad sung in his praise.

Rous Peter took over the charge of the district when a virulent epidemic was ravaging the region. Since the former collector of the district, Parish himself fell a victim to that malady, Rous Peter who was then a head assistant collector took charge.[2] Soon after taking charge he had to face the challenge posed by the great epidemic. The epidemic fever that broke out in Palni during a temple festival spread to Dindigul and Madurai [3] The Fort of Madurai became a hot-bed of the disease. As a result the epidemic became highly contagious and violently attacked all the families for more than five years from the year 1809 and took a heavy toll of lives. The disease hardly spared a house and in many cases the fever paralysed the affected person if it had not taken away the individual's life [4] It virtually wiped out many villages. About one third of the population of the district died due to this malady.[5] Agricultural activities almost came to a standstill. Rous Peter toured the district and realized the intensity of the misery that the epidemic wrought on the people. He appointed a number of native doctors to offer medical aid to the people.[6] He granted liberal remissions to the peasants without getting prior sanction from the Board of Revenue. He also explained the gravity of the situation to the government and pleaded for large scale remissions. We learn from the records that but for Peter's timely relief to the peasants the sufferings of the people would have been still worse.

As a brilliant administrator he had a perfect understanding of the revenue administration. The contact acquired with the people during his constant tours earned him much revenue details and intimacy with the people, He realised full well that the peasants in the Dindigul region had a great number of problems and suffered due to the heavy assessments fixed on their lands. Due to errors committed by Collector T.B. Hurdis who conducted a survey and fixed the assessments in 1795, the ryots were forced to pay a very heavy tax for their lands which proved to be much beyond their means. It became heavier still due to the repeated vagaries of the season. An outbreak of a famine or a drought paralysed them totally.

When arrears of revenue mounted up he realized that the permanent revenue settlement that the Company's government had fixed in this region had ruined many ryots. Therefore, when the Madras Government ordered him to proceed with the decennial renting system which was akin to the permanent settlement he wrote to them that the system would keep the problem unsolved and also mount up arrears still further.[8]

Peter wrote to the Board of Revenue to revoke the decennial settlement for, under that system the renter always called upon the lower income group for additional money to gain a profit, thus leaving the latter always at a loss.[9] He explained that if the government introduced the ryotwari system instead of the Decential settlement it would make the lower castes of inhabitants independent of the higher as each ryot would become the proprietor of his land.[10]

Peter pointed out that the ryotwari system meant more income, would be agreeable to the ryot and above all was essential for the general improvement of the country. Prior to writing to the Board he ascertained from the people about the mode of land revenue system that the people desired and found out that they favoured the ryotwari system, So he advocated for its introducttion in Madurai. He suggested a reduction in the assessment and pointed out that it would only increase the total quantity of land brought under the plough and thereby augment the income also.[11] He remarked that the ryotwari system would do away with another defect in the decennial renting system, i. e. the accumulation of arrears through years.[12] Finally when the Court of Directors agreed to his request he wanted its immediate introduction in the district as well as a general reduction in the assesment as he found the classification of of Mr. Hurdis on which the assessment was fixed was faulty.[13] Thus due to his repeated requests the government revoked the permanent settlement that wrecked the ryots and introduced in its place the ryotwari settlement which was comparatively moderate.

When a famine broke out in the year 1822 he suggested that a resurvey should be conducted as the then existing survey was obviously faulty and defective and that reduction in the teerva would help bring more fallow lands under the plough as the inhabitants would take to agriculture with pleasure. Peter personally visited many farms and lightened the tax burden of the peasants after an enquiry.[14] In addition to that he abolished the taxes on many crops like betel, plantains, turmerie, chillies, brinjals and garden lands. Such reductions induced more ryots to come forward to undertake agricultural pursuits.[15]

The hilly lands in the district near Kannivadi, Periakulam and Bodinayakkanur were infested with wild beasts like elephants which caused incalculable damage to the crops in the fields and thereby to the cultivators. But the government hardly offered any relief to them. It was only Peter who sympathised with their problems and took measures to rid them of this evil, He appointed regular watchers in the fields who scared away these animals by beating wild drums all through the night and shot at the beasts when they approached the fields. Being himself an expert marksman, Peter shot dead a number of wild elephants during his hunting tours. These measures went a long way in mitigating the sufferings of the people.[16]

Peter had great concern for the poor people who had a human approach to all their problems. The postal runners during his time were ill paid. They had an arduous task in carrying the tappal from one place to the other, for they had to run through wild jungle areas infested with wild beasts, poisonous reptiles and wicked thieves. Moreover, those runners were deprived of any possible income through cultivation as their profession did not allow them to look after their fields. So Peter recommended a higher salary to the runners and succeeded in his endeavours.[17] He also advocated their wearing a public badge of distincting, carrying a staff with inscriptions of their respective station on it, a bell at its top and a spike at the bottom.

Peter evinced great interest in the pujas and festivals of the Hindus. He was an European collector with an Indian religious thought and granted the people, among other previleges the liberty of performing the ceremonies called Astabandanam and kumbabishekam in the Sri Meenakshi temple for which he obtained one fourth of the expenditure from the government.[18] He procured a special variety of bamboos from Salem for carrying the 'vahanas' of the Sri Meenakshi tempe.[19] He wrote to the Collector of Tinneveli for a particular tree to be obtained for making the axle of the car of the temple, from the hills of Rajapalayam. Personally he made lavish gifts to the deity of the temple. They include a stone

studded zone, gold stirrups and other costly Jewels.[20] It is said that he presented a pair of gold stirrups studded with rubies to the goddess Meenakshi as thanks offering. It seems that he once shot a wild elephant, the aim missed and the elephant began to chase him. Immediately he prayed to goddess Meenakshi and fired another shot which instantaneously killed the elephant and saved him Another popular version says that one day he was sitting in his court hall and writing a judgement when a charming girl of about five years of age came to him and beckoned him. Attracted by her divinely grace, he got up and followed her. When he reached the ground floor, the child disappeared but the building collapsed. It is said that Rous Peter presented the jewels to the temple in memory of this incident.[21].

It is really sad and pitiable to note that the end of this benevolent administrator was far from peaceful. It was because he misappropriated a huge sum of money from the district treasury. He had forethought about the probable action that the government might take once it gained knowledge of his misdemeanour. So he committed suicide on 6th August 1828 leaving behind a note in his diary.[22] He confessed in his will to having considerably over drawn from his treasury and wanted his property to be sold[23] and the debts to the government cleared and also wanted the rest to be distributed among his creditors. A commission known as the Bird's commission appointed to probe into the defalcations in the treasury found out that there was a deficiency of rupees seven lakhs in the treasury.[24] As per his will his property consisting of six elephants, thirteen horses, fifteen bullocks, six hundred items of jewels with pearls and diamonds and nearly thousand items of cutlery. fire arms and books were sold out for ruppes six lakhs. No doubt as a senior merchant he had commission for the profits of the Company, but his kingly establishment compelled him to embezzle the treasury. Though the government, including Colonel Munro, the then Governor of Madras, were aware of the extravagant life that Peter led no enquiry was held on the many representations that the informers made on the embezzlement of Peter's treasury staff.[25] The British Government which sentenced Oliver Cromwell after his death praised Peter for his friendliness and liberality towards all class of Indians but condemned his degradation and sentenced three of the treasury officers who connived with Peter in the embezzlement of the treasury. It is really providential that Rous Peter escaped the trials that clive and Warren Hastings had to face in their life time. If he escaped from the wild elephants, so did he a trial before death. The people remembered him as a loveable administrator and praised him for long for all the service he had done as a collector.

References

1. Francis,W.,1878, Madurai District Gazetteer, Madras, P. 327.
2. Madurai District Record, Vol. 155, pp. 8-10.
3. Hamilton Walter, 1971, Description of Hindostan, P. 470.
4. Madurai District Record, Vol. 184. A., 20/9/1811, P. P. 3328 3348.
5. Madurai District Record, Vol. 8863, pp. 365-382.
6. Madurai District Record, Vol. 1164. p. 58.
7. Board's Proceedings, Vol. 709, 4th March 1816, p. 2040. The assessment that Hurdis fixed on the lands in Dindigul was about sixty seven percent higher than it was in former years.
8. Madurai District Record, Vol. 1156, pp. 191-193.
9. Revenue Consulations. Vol. 166, 23rd, May, 1809.
10. Madurai District Record, Vol 1156. pp. 269-272.
11. Madutai District Record, Vol. 1161, pp. 215-217.
12. Madurai District Record, Vol. 1156, p.p. 268-269.
13. Board's proceedings, Vol. 709, 4/3/1816, p.p. 2044-46.
14. Madurai District Record, Vol. 1161, pp. 140-149.
15. Francis W ,1878 Madurai District Gazetteer, Madras, pp. 191-192.
16. Madurai District Record, Vol. 4973, pp. 233-204.
17. Madurai District Record, Vol 4374, p. 18.
18. Madurai District Record, Vol 1156, p.p. 162-186.
19. Madurai District Record, Vol. 4671, p. 057.
20. Rajan, P.T., (Ed) 1963, Sri Meenakshi Temple, A Peep into its History, Souvenir, Madurai, pp. VII-VIII.
21. Ibid, P. VIII.
22. Revenue Despataches to England, Vol. 14, 19/11/1827, pp. 258 260.
23. Report of John Bird, pp. 59-64.
24. Board's Proceedings; Vol. 391, 12/11/1833, p. 5094.
25. Report of John Bird, pp. 59-64.

A BRIEF ACCOUNT OF THE EASTERN MUSLIM HISTORIANS OF THE TWELFTH CENTURY

S. SELVIN KUMAR
Lecturer in Medieval History,
School of Historical Studies,
Madurai Kamaraj University, Madurai.

In the beginning the Arabs had everything to learn from other civilisations and nothing to give as their own. But the second part of the regime of Umayads and the whole period of the Abbasids was noted for Arabs venturing on creative studies of their own. Of the different subjects on which they concentrated, historiography was an important subject and it was encouraged by the Calips as well as the civil officers. This tremendous appreciation from all quarters led to the phenomenal development of this science in the twelfth century. In this connection the Eastern Muslims contributed quite a lot for historiography and in this list Abul Fath Muhammad ibn al Kaim al Sharastani stands first.

Al Shahrastani was born in 1076 at Shahrastan near Khurasan. He studied in Jur Janiyah and Nishapur. He made his pilgrimage to Mecca in 1116 and had noticed the life of the people, their attachment to Islam and the prevailing different schools of the same religion

His important work is *Kitab al milal wat nihal*, the book of religions and sects about which he wrote in 1127. The first part of his work contains accounts of the various sects of Islam, the people of scripture alias *ahl al kitab* i.e. Jew and Christians and those of dubious revelation such as the Magi and Manichaeans. The second part of the work deals with Sabian, Greek, Muslim, Christian religions especially the system of Ibn sina, the religions of the Arabs before Islam, and of the people of India. His other works are *Tarikh al turkana* or *Al falasifa* that means a history of philosophers, *Kitab musara at al falasifa* that means discussions of the philosophers and *Kitab nihayat al iqdam fi'lm at Kalam* that means the limit of diligence in the knowledge of scholastic theology.[1]

The historical writings of Al Shahrastani are mostly on and advocating the philosophy of the Asharite school of Islam. Thereby his approach to history is philosophical and religious. His writings therefore advocated the deviation from the original orthodox systems and yet insisted on orthodoxy. The founder of Asharite Mslein, Al Ashari preaching on a pulp it said 'I un-strip myself of all my former beliefs as I myself of this garment', So saying he took off the role he was wearing and cast it from him and distributed his books among the people. One of the analogies he taught is that of the three brothers. The first one was a true believer, virtuous and pious, the second an infidel and the third an infant. All of them died and the question was posed as to what would the answer was that happen to them. The Asharites replied that the victorious would occupy a high place in heaven, while the infidel would go to hell and the infant would gain will obtain safety. So they believed in a day of strict Judgement and his writings also reveal it. So the montheistic principle and the Jewish and Christian concepts of life after death theories find a place in his writings.[2]

Al Ashair the founder of Asharite movement felt the need of a generation of wise leaders to defend their position from the opposing rationalists of that age. His ambition was substituted by As Sharastani, the historiographer of Eastern Islamic regions. Al Shahrastani held a mean between the gross anthropomorhpism of some the traditionist- and the philosophical speculations of the rational

1. Encyclopaedia of Islam, 1926, Vol. 4, p. 263.
2. Encyclopaedia of Religion and Ethics, 1953, Vol. 2, Edin burgh, p. 112.

lists. Thus while devotedly accepting the statement of the *Quran* about the face, the hands, the eyes of God, and His sitting on His throne, as articles of faith not to be interpreted as metaphorical expression, he does not take them to imply a corporas existence analogous to that of man but explains them as being His qualities free from all limitations of space Thr writings of Al Shahrastani are assuming middle position between the fatlistic and liberation schools. His writings allowed dialectic reasoning to be applied to the theological questions, thereby avoiding the gross literalism of anthropomorphic exponents of the orthodox position, and attempting to explain, situations in a rational way, prior to his times any such attempt would have been branded as heretical. With his genius Al Shahrastani assumed significance throughout the Eastern Muslim world.

A bu Sa'd Al Karim ibn Muhammad ibn Mansur at Tamini al samani was another prominent Eastern Muslim historian of the twelfth century. As his name suggests, he was a member of the Saman tribe, which is a branch of the tribe of Tamim.[3] He was born in May 1113 and travelled most most part of the life in Easte rn Islamic regions till his death in the year 1166 In 1155 he undertook an extensive study of Arabic *nisba*[4] in eight volumes, which is of great historical and geographical interest. In his work whenever he describes persons he indulges in biographical and topographical explanations- He wrote his historical works mostly basing on his discussions with learned people of that age, His main work is called *Kitab al ansab* and it is precious as a source of information to write the history of Persia, Transoxiana, and central Asia.

Ibn Hamdun was an another Historian of the Arabs who rendered a lot towards historiography in the Eastern Islamdom. He was born in 1102 at Baghdad. As he was brilliand, he he entered in the service of the Abbasid caliphs, Al Muqtabi and Al Mustanjid. It was a period of disintegration of the Abbasid supremacy. Further crusades also challenged the Calips. In 1166 Ibn Hamdun fell into disgrace and he was thrown in a prision at Baghdad where he died soon afterwards in 1167. He compiled a large collection of historical and literary anecdotes which is styled as the Book of Rememberance[5] in twelve volumes.

The next famous historian and scientist of the twelfth century was Ali Al Bayhaqi. He was born in Bayhaq Vishapur[6] in 1106 He wrote a number of works in medicine, mathematics, astrology and various other subjects and among them, his famous work is called *The History of the men of Islam.*[7] Also he wrote a *History of Bayhaq* in Persian, and completed in 1168 quite earlier than his death in 1174

Umara al Yamani, was a Shaflit historian of mipdle ages. He was born in 1121 in Yemen and he studied in Labid. He travelled to Mecca and Egypt in 1155 and he settled in Egypt in 1157. His role in politics, espeially with Saladin was a failure and as a result he was a falure and as a result he was executed in 1174 as he attempted to betray Saladin. He wrote various works and the most important is called *Kitab al Nukat al Nukat al asriya fi akhbar al wuzara al Misiriya.*[8] His work contains the religious laws of the Shafiites and therefore springs with the authority and influence of Abbasid caliphs. The religious laws are such as to allow a father to marry the daughter whom he begets in fornication, through it is regarded as blameworthy. Such thoughts are oftern referred to in his writings. During his life time he was popular in Syria, Egypt, and Western Autria.

Ibn Asakir, another historian of this line was born in Damascus in 1115 He studied in Damascus from 1126 and later he was teaching at Damascus. He was a traditionalist and his principal work is *Tarikh madinat* Dimashq [9] This is essentially a collection of biographies of the learned men of Damascus.

---

3 Tamin is an independent Arab tribe of Makkan origin who occupied the north eastern desert of Najd They fought by the side of Muhammad the Prophet at Mekkan and Hunain.

4 Patronymics.

5. Ktab at tadhkira or Tadhkira ibn Hamdun.

6. Nishapur was the capital of Khorasan.

7. Tarikh hukma al Islam.

8. Contemporary subtleties concerning the viziers of Egypt.

9. A (immense) History of Damascus.

Another historian was from Shayzar[10] and he was Murshid ibn Muniqudh, a Muslim poet, soldier and sportsmen. He flourished from 1154 to 1164 in Damascus He was participating in the crusades in 1150 to 1153, 1162 to 1164; from 1164 to 1174 and he enjoyed the Urtuqid protection in Tigris and returned to Damascus in the same year. It was in the decade 1164 to 1174 he had rest and wrote poetry rhetoric and history. The name of his important work is *Kitab al tibar.*[11] Murshid Ibn Muniqudh was fond of hunting and his biography is filled with interesting observations on the habits of hunted and hunting animals. The last part of the work is exclusively devoted to falconry and chase. Further he explains the differences between cheetahs and leopards Also he describes about the various kinds of fishing The *Kitab* of his contain-many aneedotes on the customs of Franks such as ordeal by water, other inferior medieval practices, and unusual wounds and cures.

The Persian historian to assume prominence was I mad al Din Isfahani. He was born at Ispahan in 1125 and he was educated at Baghdad. He served under Saladin and after Saladin,s death devoted himself to literary work. He wrote a history of Saladin's conquest of Syria and Palestine,[12] a history of the Saljuk rulers and their Vizier's[13] and the historical memories.[14] It is believed that he has written a series of essays on falconry.

The last in this Eastern Muslim School of thinkers of historiography was Yusuf Ibn Rafi. He was born in Musul in 1145 aud studied at Baghdad and began his career as teacher at Nizaneiah and become a Professor at Musul. Also he was serving as a judge at Aleppe and died there in 1234. He was a Shafiite and his historical writings have the impact of this philosophy. He write the History of Saladin, and History of Aleppo.

The medieval historians of the Eastsrn Muslim world generally distinguished in the art of supporting the religious sects to which they belonged. Thereby without any doubt they attained significance in the society. Further the discipline of medieval Muslim historiography in the East was mainly not intended to specialise in the art of writing history whereas they specialised in different sciences of which historiography was one. Moreover they were good biographers who even invented techniques to write the history of prominent men, attaching important not only to the name but also to the topography and local history. Ehey were mostly encouraged by the state, and they had education in the good academic institutions of the medieval ages. Though most of the historians concentrated on religious history, a few of them wrote on regional History. However most of them stood off from narrow regionalism and non-secularism. Few of them were officials under prominent rulers like Saladin and few of them were Judges and some others were sportsmen who wrote history totally from a different approach incorporating in their writings different disciplines of study in the medieval times.

---

10. Near Orontes.
11. Learning by example.
12. Kitab al fath al qussi.
13. Kitab nusral al fatra.
14. Kitab al barq al shami.

DETERMINANTS OF FOODGRAIN PRICES IN THE INDIAN ECONOMY : 1951 - '64

M.V. SATCHITANANDAM
Dept. of Economics, Madurai Kamaraj University

I. Purpose :

The purpose of this paper is two - fold:

1. to analyse the dynamic implications of "changing stocks" and "speculative demand on prices of Foodgrains and a majos cereal like rice, and
2. to stress the differences in price patterns and their determinants for 'foodgrains group' as a whole and a major constituent cereal like rice.

The variant price behaviour pattern for the 'group' as a whole and an item like rice, it is concluded, renders the implications, developmental and deterministic on the basic of foodgrains group only, too sumpliotic. (Mellor and Dar 4, Adhvaryu and Patel 1, Raj 6)

In section II the proposed model is set out. in section III the results are discussed and some conclusions are drawn in section IV.

II. The Explanatory Model Consists of a demand Function,

$$D_{t-1} = b_1 + b_2 P_{t-1} + b_3 Y^b_{t-1} \quad \ldots\ldots \quad (1)$$

in terms of total demand D_{t-1}, Price, P_{t-1} and income Y_{t-1} during any period (t - 1); b is an income elasticity of demand, obtained from cross section data or other sources; b_1, b_2, b_3 are Parameters.

An exogenously given supply variable, S_{t-1} ......(2)

and a *Price determining equation in markets*

$$Pt = P_{t-1} + K (D_{t-1} - S_{t-1}) \quad \ldots\ldots(3)$$

K, being the adjustment coefficient.

The price determining equation is of the Walrasian market adjustment type Henderson and Quandt, 3, P 136-137) or can even be considered as a price setting equation by stockists as a whole, either farmers or traders implying that price change is proportional to excess demand, the adjustment coefficient being K.
(Allen, 2a, pp 15-16)

By substitution of (1) and (2) in (3) and writing $(b_3 Y^b_{t-1} - S_{t-1})$ as $(D_{t-1} - S_{t-1}$ or $(D-S)_{t-1}$ the *price function* is obtained as

$$P_t = Kb_1 + (1+Kb_2) P_{t-1} + K (D - S)_{t-1} \quad \ldots\ldots \quad (4)$$

A Koyck type distributed lag functional form in

$(D-S)_{t-1}, (D-S)_{t-1} \ldots$ for P_t

Thus. our, single equation explanatory model for determination of foodgrain pricesis

$$P_t = a_t + a_2 P_{t-1} + a_3 (D-S)_{t-1}$$

where $a_1 = Kb_1$, $a_2 = 1 + Kb_2$, $a_3 = K$ ...... (5)

In the estimation of prices of rice, a variant of the above model involving speculative demand is used.
(Allen 2b, pp 235-236)

$$D_{t-1} = C_1 + C_2 P_{t-1} + C_3 (P_{t-1} - P_{t-2}) + C_4 Y^b_{t-1} \quad \ldots \quad (6)$$

speculative demand is indicated as dependent on price change $\triangle P_{t-1} = (P_{t-1} - P_{t-2})$. Simplifying, using (2) and 6) in stock adjustment equation (3), the price function with speculative demand is

$$P_t = d_1 + d_2 P_{t-1} + d_3 P_{t-2} + d_4 (D-S)_{t-1} \ldots\ldots (7)$$

$$d_1 = KC_1, d_2 = (1 + KC_2 + KC_3), d_3 = -KC_3,$$

$d_4 = K (D-S)_{t-1}$ being $(C_4 \; Y^b_{t-1} - S_{t-1})$.

If we add a term in M_t, money supply to (5) and (7) it reflects the influence of rising money supply on sectoral prices, consequent changes in distribution of income, and so effect on income elasticity of demand (Mellor and Dar 4), or alternatively if the equation implies price setting by Merchants, their costs and other trend influences are supposed to be approximated by M_t. (Stojkovic, 9)

Thus our basic price functions are

$$P_t = a_1 + a_2 P_{t-1} + a_3 (D-S)_{t-1} + a_4 M_t \quad \ldots (8)$$

a_1, a_2, a_3 in terms of Model parameters given In equation (5) and

$$P_t = d_1 + d_2 \; P_{t-1} + d_3 \; P_{t-2} + d_4 (D-S)_{t-1} + d_5 \; M_t \quad (9)$$

d_1, d_2, d_3, d_4 as in equation (7). Equation (8) implies a stock adjustment and Equation (9) speculation also

III Results :

For foodgrain prices, an ordinary least squore estimate for the period 1952-1963 of co efficients of equation (8) are given by.

$$P_t = 14.406 + 0.5262 \underset{(0.1921)}{P_{t-1}} + 2.1785 \underset{(0.7461)}{(D-S)_{t-1}} + 1.1750 \underset{(0.3514)}{M_t} \quad \ldots\ldots (10)$$

$R^2 = 0.7989$, Adjusted $R^2 = 0.7223$, Von Neu mann ratio = 2 215, the figures in brackets below coefficient in regression (10) are standard errors. All the Coefficients in the regression (10) are significantly different from O and the absence of auto-correlation is indicated by the value of Von-Neumann ratio.

P_t = Average monthly wholesale price index with base 1952-53 = 100 from March t to February (t+1), obtained from Reeerve Bank of India, Monthly Bulletins. $(D-S)_{t-1}$ values are taken from (Mellor and Dar, 4) in which

$D_t = L_t \left\{ Q \left(1 + \frac{\Delta Y}{Y}\right)^b \right\}$, L_t = population in year t - t+1

Q = Per capital consumption in year 1949-50 in million Long tons, Y = per capital real income in 1949-50,

Δ Y = Increase in per capita real income by period t Y is obtained from Central Statistical Organisations, Government of India.

S_t = Aggregate supply in million long tons in period t a sum of production after allowance for feed, seed and wastage, imports and change in Government stocks.

M_t = Money supply during April of year t obtained from Reserve Bank of India monthly bulletins. b = Income elasticity of foodgraing taken to be 0.5 from National Sample Survey & National Council of Applied Economic Research estimates.

Droping the variable P_{t-1}, the above Regression is re-estimated, giving

$$P_t = 56.75 + 2.1338 \underset{(0.9774)}{(D-S)_{t-1}} + 1.5119 \underset{(0.4214)}{M_t} \quad \ldots (11)$$

$R^2 = 0.6114$, Adjusted $R^2 = 0.5138$, Von Neumann ratio = 1.604, indicating no auto correlation, and statistically significant coefficients.

i) Comparing (10) and (11), it is found that the omission of the variable P_{t-1}, is reflected not as much in the parametric estimates which almost remain the same, as in adjusted R^2 which is reduced consider ably. P_{t-1}, thus appears to be a superfluous variable (Rao & Miller, 7, pp 32-37) for the explanation of P_t. Thus the stock adjustment model of equation (5) does not seem to be appropriate for 'foodgrain prices' as a whole, An alternative specification of P_t as in regression (10), in terms of $(D-S)_t$ and $(D-S)_{t-1}$, with no price variable gives reduced R^2 as also high standard error for $(D-S)_{t-1}$ as Mellor & Dar 4 have noted:

Mellor & Dar 4 specify P_t as price index in first week of April of year t, and fit a similar function to conclude, that on an assumption that traders clear srocks each year - end, their function

$$P_t = 41.48 + 0.56 \underset{(0.08)}{(D-S)_{t-1}} + 2.25 \; (0.80)$$

$(D-S)_{t-2} + 2.06M_t$ ..... (12)
(0.35)

R^2 = 0.83, is a good indicator of impact of farmers stocks $(D-S)_{t-1}$ on prices in every stable price period April.

$(D-S)_{t-2}$ of the above function roughly corresponds to $(D-S)_{t-1}$ in Regression (10) The closeness of values of (10) and (12), as also the high standard error of $(D\ S)_{t-2}$ coeffiicient in comparison with that of $(D-S)_{t-1}$ in (12) may imply a misspecification of $(D\ S)_{t-1}$, which does not seem so serious in the case of Regression (10).

A lingering doubt is whether prices of foodgrains, can be reasonably explained in terms of stocks ; either Farmers' (as in Mellor & Dar 4) or traders', as in this model. Foodgrains, being an amorphous group of disparate items, no price determination model is appropriate; only a 'Forecast equation' can be adopted. In such a case Equation (10) is another fair alternative to equation (12) of Mellor & Dar, in which P_{t-1} serves as a proxy for the impact on supply and Demand through incomes, for the suceeeding year (Mellor & Dar 4, pp 967 - 968) Of course, instead of this 'single equation Juggling' one could specify a' simultaneous equation system' similar to that of Girshick, M A. and Haavelmo. T. (Econometrica, April 1947 pp 78—110, Statistical Analysis of Demand for food).

ii. From equation (5), an estimate of $b_2 = \frac{a_2 - 1}{a_3}$ which is equivalent to writing a long run specification of the short run equation (5), by putting $P_t = P_{t-1}$ and interperting $(D-S)_{t-1}$ as the balance of demand over supply, to be cleared in each time period so that

$$\frac{d}{dP}(D-S)_{t-1} = \left(\frac{1-a_2}{a_3}\right).$$

$\left(\frac{1-a_2}{a_3}\right)\frac{\bar{P}_t}{\bar{S}_{t-1}}$ bears an interpretation of price elasticity of demand in the long run, the average supply over the years of study $\bar{S}_{t-1}$, being identical with average demand because of Market clearance in the long run. $\bar{P}_t$ is the averaged price index over the years of study. With b_2 = — 0.22 from regression (10), Price elasticity of demand over the period 1952 - 1963 is found to be 0.33; which agrees very well with the value estimated by (NCAER 5b, p 57) for foodgrains in the period 1950-1965, in a static context. This correspondence is some argument in favour of the regression (10) and its independent variables. Regression (11), based on "complete market clearing" assumption, leads to a price elasticity of demand equel to 0 70; while Mellor & Dar's regression (12), gives a value 0.55; Since Regression (10) only agrees with an independent estimate (of NCAER) available, it may be judged a satisfactory forecasting model on this basis.

iii) (10) and (12) also suggest that in equation (10), the impact of money supply on prices is relatively weakened, perhaps because the price variable P_{t-1} forecasts not only future supplies and demand, but also the effects of income distribution, elastidities in different income groups in a closely preceding period.

Estimated equation for rice are as below for the period 1951-1964.

$$P_t = 4.4861 + 0\ 5137\, P_{t-1} + 0.7579\, (D\text{-}S)_{t-1}$$
(0.1923) (0.3586)
$$+ 0\ 9232\, M_t\ (0.2339)$$

Adjusted $R^2 = 0.8208$, Von-Neumann Ratio = 2-94...... (13)
.... Equation (8) type

$$P_t = 21.1836 + 0.8786\, (D\text{-}S)_{t-1}$$
(0.4711)
$$+ 1\ 3550\, M_t$$ ...... (14)
(0 2317)

Adjusted $R^2 = 0.7285$, Von Neumann ratio $= 1.708$

$$P_t = 16.6884 + \underset{(0.1987)}{0.7716}\, P_{t-1} - \underset{(0\ 2097)}{0.4959}\, P_{t-2} + \underset{(0.3387)}{0.6068}\, (D\text{-}S)_{t-1} + \underset{(0\ 1965)}{0.9461}\, M_t \quad \ldots (15)$$

...... Equation (9) type

Adjusted $R^2 = 0.8918$. Von Neumann Ratio $= 2.1242$. The Von-Neumann ratio indicates in all regressions (13) to (15) lack of auto correlation among residuals. The standard errors[a] (in brackets below numerical co-efficient (5%, right tailed t test) except that of $(D-S)_{t-1}$ in (15), which is only significant at 10% right tailed test. P_t is average of monthly wholesale price indices with 1952-53 = 100 from July t to June t+1 obtained from Bulletin of Food statistics; Government of India. $D_t = Q\left((1 + \frac{\triangle Y}{Y}\right)^b$, D_t being per capita demand in period t = Per capita consumption of rice in Kilograms, in 1949-50. Y = per capita real income income in 1949-50. $\triangle Y$ = increase in per capita real income by period t. S_t = per capita availability in kilograms (sum of production imports and Governments') change in stocks per capita) b, the income elasticity of demand for rice taken to be 0.28 (NCAER 5b, page 58, and 5c, page 71). The $(D_t - S_t)$ series is computed from data of NCAER 5a, p 102. M_t is per capita money supply during March of year (t+1), obtained from Reserve Bank of India monthly bulletins.

iv) The omission of P_{t-1} in Regressions (13) and (14) leads to higher parametric estimates in the case of price function for rice with no considerable influence on adjusted R^2. P_{t-1}, thus is a highly relevent variable (Rao & Miller, 7), whose omission leads to an over estimation of influence of money supply and excess demand variable. Thus, in Regression (13), co-efficient of P_{t-1} is not taken to represent residuary influences on P_t, through its effect on supply S_t, and Demand D_t to the same extent as in the case of foodgrains, but it is interpreted as conforming to the influence of a stock adjustment model as in equation (4). Analytically for a single crop like rice, P_{t-1} may have relatively (as compared with foodgrains), lower influence on demand D_t and supply S_t, and consequentially on P_t. So it is believed that the significance of P_{t-1} in regression (13) is evidence for a stock adjustment model. The higher adjusted R^2 for regression (13) than for (10) may also by in favour of a stock adjustment model for an individual cereal like rice than for all of the foodgrains put together.

v) Regression (15) with 'speculative demand' gives very high adjusted R^2, explaining 89% of variation of P_t over the period 1951-64. From (7) and (15) we find K, the adjustment coefficient = 0.6068, C_3 = speculative demand effect = 0.8172, C_2 = lagged price coefficient = — 1. 1936 (Equation (6)). The speculative demand effect suggests that a higher increase in price leads to expectation of further rice in prices and hence to increase in demand and conversely (equation (6)). The high standard error of $(D-S)_{t-1}$ relatively to that of other coefficients in regression (15) suggests that presence of speculative element reduces the importance of past excess demand, in terms of income as a a determinant of current price.

vi) From regression (13) and equation (5), b_2 = — 0.64, and identifying demand D_t as the long run average per capita availability during the years 1951-64, the price elasticity of demand is estimated to be 1.088. Mrs. Thamarajakshi 8, pp 303-305, obtains price flexibility coefficient (negative of inverse of price elasticity of demand) to be — 0 8183 during 1952-68, giving a price elasticity of demand = 1.22, sufficiently close to that from regression (13). The long run estimate of elasticity of demand from regression (15) is a very high value of 2.0825, when speculation and stock adjustment are neutralieed in a static long run context. The higher value, with regression (15) as compared to

(13), for price elasticity of demand implies that the extremely elastic nature of demand for rice during th s period 1951-64 is rendered less elastic by the presence of speculative demand, in consonance with the positive sign of C_3, 'Speculative demand' coefficient in equation (6). From the movement of demand elasticity from a static (no speculation) level of 1.22 to 1.088 (speculation and no stock adjustment) to 2 0825 (no speculation nor stock adjustment), it is inferred that while speculative element, contributes to price fluctuations, because of some inelasticity, the stock adjustment to some extent limits them.

IV. Conclusions :

1. The impression that the paper desires to convey is that, while for a group of disparate items like foodgrains as a whole, any 'price determination equation' is subject to specification and/or aggregation errors leading to doubtful results, for a major cereal item say rice in the group. more positive conclusions are possible. This, it is expected, is substantiated in section III of this paper. Mellor & Dar's 4 peculiar assumption of 'Market clearance' each year by traders for the whole 'foodgrains' group leads to a misspecification of the $(D\text{-}S)_{t-2}$ variable (Regression - 12) the on-form stocks of farmers. Naturally, with such a model, mnney supply is over-emphasised in determination of Prices. (Adhvaryu and Patel, 1). The lag coefficients of Mellor and Dar Regression-12 look odd, in spite of the justification, they offer (Mellor and Dar, 4 At best, a price function in the given period for a group as foodgrains can serve the purposes of 'forecast' and not of an explanatory model. In this sense Regression-10 can perform equally well as Mellor and Dar's (4); for with this specification (with P_t as average prices), there is not such a dramatic reduction in R^2 as, Mellor and Dar 4, food note 3, p 964 observe with their regression with average prices of an year substituted for April prices. Since we have not attempted forecasts for data outside the observation period (to some extent, impossible due to institutional changes like state trading, price controls etc.), no conclusion is available regarding the reliability of forecasts on basis of regression-10 Vis 'a' Vis those of Mellor and Dar (4). However, within the observation period of 1952-63, the estimated prices reproduce the movements of observed prices as closely as those of Mellor and Dar's (4) regression 12. We thus, regard Regression-10 as a fair alternative to Mellor and Dar's, 4.

2. While for 'foodgrain group' as a whole, it may be intuitively reasonable to expect no speculative influences on prices (Raj, 6), the regression (13) to (15) positively suggest its presence as also storage and stock adjustments for a particular cereal, Rice.

   It is observed, that for observed and estimated prices from 1951 to 1958, for Rice, Regression (15) fits more closely than (13) or (14) (The figures and data will be supplied on request). The observed price movements during 1958-'61, by all three regressions are contrary to predictions because of state trading. From 1959-'63, the closeness of all three regressions and also with observed prices, to some extent, indicate systematic price controls with interzonal restriction and consequent movements only in (D-S) variable, production changes, all the other variables being controlled. The impact of controls, and state trading on prices is an area worth intensive study for a single food-crop like rice, though it is not investigated in this preliminery study.

3. A limitation of this study is that the role of money supply in effecting price changes has not been deeply examined, except for implications suggested by Mellor and Dar (4). Though for regressions (13) to (15), the money supply variable is highly significant, it is not so dominent as Mellor and Dar (4) assume. We exceyt to continue a study of the reason for reduced impact of money supply variable relatively to that in Mellor and Dars (4) regression (12).

4. The areas in which this work is incomplete and needs further extension are a) the demand function assumed in equation (1) and its mixed nature. b) The relations between price elasticities of demand and income elasticities of demand and their consistency with Slutsky relation, (Mellor and Dar (4), p 973)

c) Construction of an aggregated demand function for foodgrains as a whole from major individual items,

d) Certain development implications of price behaviour of 'rice' may be spelt out, at least

for a major rice consuming Zone like South India, but we fight shy of doing this in this preliminary study.

To conclude, this preliminary study may be considered worthwhile, if it discourages temptations to draw facile conclusions oa the basis of price movements in an aggregate like Foodgrains, group' through single equation models and divert' attention to price analysis of individual crops and their aggregation for the group as a wholes since the group behaviour seems throw up results at variance with price behaviour of major individual crop constituents.

References

1) Adhvaryu J.H. & Patel, A.S. : "Determinants and Development implications of Foodgrain prices inIndia" comment 'American Journal of Agricultural Economics', 1969, pp 939-940 and Reply by Mellor J.W. and Dar A K. (Same issue) pp 941-942

2) a) Allen, R.G.D. : 'Mathematical Economics' Macmillan, 1970 pp 15-16

b) Allen, R.G.D. : 'Mathematical Analysis for Economists,' Macmillan & co., London, 1953.

3) Henderson J.M: and Quendt R.E. 'Micro - Economic Theory' McGraw - Hill (International Student Edition) 1958

4) Mellor J.W. and Dar A.K. 'Determinants and Develoment implications of Foodgrain prices in India' (1949-1964) 'American Journal of Agricultural Economics 1968 : pp 962 - 974

5) NCAER National Council of Applied Economic Research : New Delhi

a) 'Structure and Behaviour of prices of foodgrains' 1969

b) 'Projection of Demand & Supply of Agricultural commodities' 1970

c) 'All India consumer Expenditure Survey : Volume II, 1967

6) Raj, K N. 'Price Behaviour in India 1949-1966. An explanatory Hypothesis' Readings in Indian Agricultural development, Edited by Pramit Chowdhury, George Allen & unwin, London, 1972 pp 168-175

7) Rao, P. & Miller, L.R. : Applied Econometrics, Prentice-Hell 1971, pp 32-37

8) Dr. Thamarajakshi, R : 'Cereal prices in the Indian Economy' Agricultural situation in India' August 1971 pp 303-305

9) Stojkovic, G. : "Market models for Agricultural Products chapter 13 in Wold H.O (Editor), 'Econometric model building', North Holland Publishing Co., Amsterdam 1962

FACTOR PRODUCTIVITY AND REGIONAL EFFICIENCY IN INDIAN SUGAR INDUSTRY

G. SUBRAMANIAN*

Introduction :

Sugar industry is one of the largest and traditional industries in the country with a weight of 3.5% in the General index of industrial production and of nearly 10% in its consumer non-durable goods segment. It is the largest among the processing industries, next only to cotton textiles. It is an agro-based industry with a large employment potential. About 6% of the total factory lobour is employed in this industry. It has a wide regional spread. Being an industry producing an essential commodity, its importance need not be emphasised further.

In this paper an attempt is made to measure efficiency across regions in terms of "Relative Partial Labour Productivity" (RPLP), "Relative Partial Capital Productivity" (RPCP), "Relative Total Factor Productivity" (RTFP) as defined by Kendrick and a new measure of Relative Total Factor Productivity as suggested by Jani and Jaiswal for the industry during the periods 1953, 1955, 1960, 1965 and 1969. The analysis is carried out at the regional and national levels for the industry under study. For purpose of Economic policy, States are regarded as "regions" in this study. The selected regions for this study are Uttar Pradesh, Bihar, Maharashtra, Tamil Nadu and Andhra Pradesh These regions together contribute more than 90 per cent to total sugar output.

The important sources of data for this study have been "Census of Indian Manufactures" (CMI) and "Annual Survey of Industries" (ASI). The main feature of this paper is that all inputs and outputs are expressed in real terms, particularly the input capital has been adjusted for price variation and capacity utilisation. The way in which inputs and output adjusted are given in the appendix.

The plan of the paper is as follows: Following the introductory note, first section provides RPLP and RPCP for the industry at the regional level during the periods 1953, 1955, 1960, 1965 and 1969. Further, regions are ranked with regard to efficiency which is defined in terms of RPLP and RPCP. The relative position of the region with regard to efficiency has been examined through the rank correlation coefficient between the periods 1953 and 1969. Second section deals with TFP and RTFP as defined by Kendrick. Moreover, the relative position of the regions with regard to efficiency has been examined through the rank correlation coefficient. In the third section, TFP is defined as the Geometric mean of labour and capital productivities and thereby RTFP has been computed for the regions under study. The relative position of the regions with regard to efficiency has been examined through the rank correlation coefficient between the periods 1955 and 1969. Main findings are given in the last section.

Notations :

$V_{j,t}$ = Value added by the industry in the jth region for the year t (Rs. in crores).

$V_{i,t}$ = Value added by the industry at all India level for the year t (Rs. in crores).

$L_{j,t}$ = Total number of man-hours employed by the industry in the jth region for the year t (in crores)

$L_{i,t}$ = Total number of man-hours employed by the industry at all India level for the year t (in crores)

$C_{j,t}$ = Fixed capital employed by the industry in the jth region for the year t (Rs. in crores).

* Faculty Member,
Department of Economics, Madurai Kamaraj University.
The author's thanks are due to Dr. N. S. Raghavan, Dr. Jani and Dr. Jaiswal for their valuable suggestions and help. It is a part of my Ph.D. thesis, submitted to Madurai Kamaraj University.

$C_{i,t}$ = Fixed capital employed by the industry at all India level for the year t (Rs. in crores)

$W_{j,t}$ = Total wages and salaries paid by the industry in the jth region for the year t (Rs. in crores)

$W_{i,t}$ = Total wages and salaries paid by the industry at all India level for the year t (Rs. in crores).

Relative Partial Labour Productivity (RPLP) and Relative Partial Capital Productivity (RPCP).

In order to compare the labour productivity of a region for the industry in a particular year with that of the Economy as a whole in the same year, we obtain the relative partial labour productivity (RPLP) which is given by

$$(RPLP)_{j,t} = \frac{\frac{V_{j,t}}{L_{j,t}}}{\frac{V_{i,t}}{L_{i,t}}} \qquad J = 1, 2, 3, 4, 5 \quad t = 0, 1, 2, 3, 4$$

If $(RPLP)_{j,t} > 1$, j^{th} the region is more efficient compared to all India level with reference to labour productivity for the year t.

If $(RPLP)_{j,t} = 1$, j^{th} region is equally efficient compared to all India level with reference to labour productivity for the year t.

If $(RPLP)_{j,t} < 1$, j^{th} region is less efficient compared to all India level with reference to labour productivity for the year t.

Similarly, the relative partial capital productivity in the jth region for the year t is given by

$$(RPCP)_{j,t} = \frac{\frac{V_{j,t}}{C_{j,t}}}{\frac{V_{i,t}}{C_{i,t}}} \qquad J = 1, 2, 3, 4, 5 \quad t = 0, 1, 2, 3, 4$$

If $(RPCP)_{j,t} > 1$, j^{th} region is more efficient compared to all India level with reference to capital productivity for the year t.

If $(RPCP)_{j,t} = 1$, j^{th} region is equally efficient compared to all India level with reference to capital productivity for the year t.

If $(RPCP)_{j,t} < 1$, j^{th} region is less efficient compared to all India level with reference to capital productivity for the year t.

The values of RPLP and RPCP are given in Tables 1 and 2 respectively.

TABLE 1

RPLP AND EFFICIENCY RANKING

Sample period / Regions	1953	Ranking	1955	1960	1965	1969	Ranking	Mean
Uttar Pradesh	1 72 (.92)	4	2 29 (1.04)	2.40 (.77)	2.72 (.73)	3.22 (.80)	4	2.47 (.83)
Bihar	1.70 (.91)	5	1.97 (.89)	1 87 (.60)	2 78 (.74)	2.88 (71)	5	2.24 (.75)
Maharashtra	3.53 (1 90)	1	4 79 (2.17)	5.22 (1.68)	4.63 (1.24)	6.28 (1.56)	1	4.89 (1.64)
Tamil Nadu	2.02 (1 09)	2	2.49 (1.13)	2.92 (.94)	4 14 (1.27)	4.81 (1.19)	3	3.28 (1.10)
Andra Pradesh	1.98 (1.06)	3	3.19 (1.44)	5 06 (1.63)	3.27 (.87)	5.87 (1.46)	2	3.87 (1.29)
All India	1 86		2 21	3.10	3.74	4 03		2.99

NOTE : Figures are Partial Labour Productivities. Figures in brakets are RPLP.

$$\text{Rank correlation coefficient} = 1 - \frac{6\,\Sigma\,D^2}{N(N^2-1)} = .9$$

TABLE 2

RPCP AND EFFICIENCY RANKING

Sample period / Regions	1953	Ranking	1955	1960	1965	1969	Ranking	Mean
Uttar Pradesh	2.19 (1.31)	2	2.47 (1.34)	1.69 (1.27)	1.00 (1.22)	1.27 (1.51)	1	1 95 (1.33)
Bihar	2.47 (1 48)	1	2.50 (1.36)	1.15 (1.22)	1 30 (1 59)	1.25 (1.49)	2	1.73 (1.18)
Maharashtra	1.09 (.65)	3	2.31 (1.26)	.71 (.76)	.57 (.70)	.71 (.85)	5	1.08 (.73)
Tamil Nadu	.75 (. 45)	5	.59 (.32)	.65 (.69)	1.27 (1.55)	1.00 (1.19)	4	.85 (.58)
Andhra Pradesh	.77 (.46)	4	.73 (.40)	1.15 (1.22)	.63 (.77)	1.04 (1.24)	3	.86 (.59)
All India	1.67		1.84	.94	.82	.84		1.47

NOTE : Figures are PCP. Figures in brackets are RPCP.

$$r_k = 1 - \frac{6\,\Sigma\,D^2}{N\,(N^2-1)} = .6$$

Kendrick's Measures of Productivity :

Kendrick's measures of productivity is called productivity measures in the sense that they take account of both capital and labour. This is supposed to reflect the "residual" or "technical progress" which cannot be attributed to either of the two factors of production. Compared to Partial Productivity measures this method is necessarily more important in the sense that they provide us with a 'measure' of 'technical progress'. It is based on linear production function of the form

$$V = \alpha L + \beta C$$

Assuming perfect competition in the factor and commodity markets, the total factor productivity for the industry in the jth region for the tth year is given by

$$(TFP)_{j,t} = \frac{V_{j,t}}{W_{jo} L_{j,t} + R_{jo} C_{j,t}}$$

where W_o and R_{jo} are the base year (1953) remunerations of labour and capital. With the above formula, total factor productivity for the base year (1953) is equal to one in all the regions for the industry under study. Now the relative total factor productivity in the jth region for the tth year is given by

$$(RTFP)_{j,t} = \frac{\dfrac{V_{j,t}}{W_{jo} L_{j,t} + R_{jo} C_{j,t}}}{\dfrac{V_{i,t}}{W_{io} L_{i,t} + R_{io} C_{i,t}}}$$

If $(RTFP)_{j,t} > 1$, j^{th} region is more efficient compared to all India level with reference to total factor productivity for the year t.

If $(RTFP)_{j,t} = 1$, j^{th} region is equally efficient compared to all India level with reference to total factor productivity for the year t.

If $(RTFP)_{j,t} < 1$, j^{th} region is less efficient compared to all India level with reference to total factor productivity for the year t.

The values of TFP and RTFP are given in Table 3

TABLE 3

TFP AND RTFP (KENDRICK'S MEASURE)

Regions / Sample period	1953	1955	Ranking	1960	1965	1969	Ranking	Mean
Uttar Pradesh	1 00	1 17	2	.68	.60	.75	3	.80
		(1 04)		(96)	(.92)	(1.12)		(1.01)
Bihar	1 00	1.06	3	.59	.67	.67	5	.75
		(.94)		(.83)	(1 03)	(1 00)		(.95)
Maharashtra	1 00	1.98	1	.70	.56	.71	4	.99
		(1 75)		(.99)	(.86)	(1.06)		(1.25)
Tamil Nadu	1.00	.85	5	.94	1.76	1.47	2	1.26
		(75)		(1.32)	(2.71)	(2.19)		(1.59)
Audra Pradesh	1.00	1.05	4	1.64	1.89	1.51	1	1.52
		(93)		(2.31)	(2.91)	(2.25)		(1.92)
All India	1.00	1.13		.71	.65	.67		.79

NOTE : Figures are TFP Figures in paranthesis are RTFP

$r_k = -.6$

TFP and RTFP (Jani and Jaiswal Measure) :

While measuring TFP given by Kendrick, we note that the denominator consists of labour input (in value terms) as well as fixed capital both measured with respect to the base year price level Further, Kendrick's measure should be very near to the measure of partial capital productivity as the denominator in the Kendrick's formula consists of the major part of the total productive capital employed. In this section, a new measure given by Jani and Jaiswal is used, which may be regarded as a measure of TFP. According to Jani and Jaiswal, total factor productivity is the Geometric mean of Labour and Capital productivities.

$$(TFP)_{j,t} = \sqrt{(LP)_{j,t} \times (CP)_{j,t}}$$

$$= \sqrt{\frac{V_{j,t}}{W_{j,t}} \times \frac{V_{j,t}}{C_{j,t}}}$$

$$= \frac{V_{j,t}}{\sqrt{W_{j,t} \times C_{j,t}}}$$

Similarly,

$$(TFP)_{i,t} = \frac{V_{i,t}}{\sqrt{W_{i,t} \times C_{i,t}}}$$

Hence,

$$(RTFP)_{j,t} = \frac{\dfrac{V_{j,t}}{\sqrt{W_{j,t} \times C_{j,t}}}}{\dfrac{V_{i,t}}{\sqrt{W_{i,t} \times C_{i,t}}}}$$

If $(RTFP)_{j,t} > 1$, j^{th} region is more efficient compared to all India level with reference to TFP for the year t.

If $(RTFP)_{j,t} < 1$, j^{th} region is less efficient compared to all India level with referencd to TFP for the year t.

If $(RTFP)_{j,t} = 1$, j^{th} region is equally efficient compared to all India level with reference to TFP for the year t.

The values of TFP and RTFP are given in Table 4.

TABLE 4

TFP AND RTFP (JANI AND JAISWAL MEASURE)

Sample period / Regions	1953	Ranking	1955	Ranking	1960	1965	1969	Ranking	Mean
Uttar Pradesh	2.53	3	3.13	3	2.52	2.19	2.61	5	2.60
	(1.10)		(1.11)		(.99)	(.93)	(1.10)		(1.05)
Bihar	2.66	2	3.35	2	2.41	2.68	2.81	3	2.78
	(1.16)		(1.26)		(.95)	(1 14)	(1.18)		(1.12)
Maharashtra	2.93	1	4.68	1	2.77	2.22	2 77	4	3.07
	(1.27)		(1.66)		(1.09)	(.94)	(1 16)		(1.24)
Tamil Nadu	1 87	5	1.82	5	1.96	3.01	2.91	2	2.31
	(.81)		(65)		(.77)	(1.28)	(1.22)		(.93)
Andhra Pradesh	2.02	4	2.50	4	3.27	1.87	3.19	1	2.57
	(.88)		(.89)		(1.28)	(.79)	(1.34)		(1.04)
All India	2 30		2.82		2.55	2.36	2.38		2.48

NOTE : Figures are TFP. Figures in parenthesis are RTFP.

$r_k = -.6$

The main findings are :

1. The study shows on an average that the Maharashtra, Tamil Nadu and Andhra Pradesh seem to be most efficient regions as compared to all India level of labour productivity (vide last column of Table 1). Further, the relative position of the regions with regard to efficiency (RPLP) remains unaltered as their rank correlation coefficient is not significantly different from unity between the periods 1953 and 1969. In fact it is .9.

2. As far as capital productivity is concerned, Uttar Pradesh and Bihar seem to be most efficient regions as compared to all India level (vide last column of Table 2). Further, the realative position of the regions with regard to efficiency (RPLP) remains unstable as their rank correlation coefficient (r=.6) is significantly different from unity.

3. The two measures of TFP which we attempted, by and large, yield the same result. Regarding TFP, Kendrick's measure has shown that Maharashtra, Tamil Nadu and Andhra Pradesh seem to be most efficient regions compared to all India level (vide last column of Table 3). As the rank correlation coefficient is negative in both tht measures, we may infer that the relative position of the regions with regard to efficiency have undergone drastic changes between the periods 1955 and 1969. (Vide Table 3 and 4). This improvement in ranking in these regions may be due to higher labour and total factor productivities during later years. Further, improvements in labour productivity both partial and total factor productivity may be due to substantial capital deepening in these regions during the period under study.

References

1. Asit Banerji (1976) "Capital intensity and productivity in Indian Industry", Macmillan Co., New Delhi.

2. Beri, G.C., (1962) "Measurements of Production and Productivity in Indian Industry", Asia Publishing House

3. Dholakia, B.H., (1974) "The Sources of Economic Growth in India", Good Companions, Baroda.

4. Jani, B.B,. and Jaiswal (1976) "Total Factor Productivity and Measures of efficiency of certain Major industries in India", Economic Research Journal, Vol. XXII, No. 4, March.

5. Kendrick, J.W., (1961) "Productivity trends in U.S.A.", Princeton University Press, Princeton.

6. Kendrick, J.W., (1956) Productivity trends: Capital and Labour", Review of Economics and Statistics, Vol. 38, pp. 248-257.

7. Sinha and Sawhney (1970) "Wages and Productivity in selected Indian Industries", Vikas Publications, Delhi.

8. Subramaniyan, G., (1977) "An alternative form of Production functions for Tamil Nadu Sugar Industry", Journal of the Maduai University, Vol. VI, No. 11, pp, 13-15.

APPENDIX

A.S.I. and C.M.I have publised data on gross output of sugar and its by-products; value added by sugar industry; various raw materials and fuel used, etc., at current prices and in physical quantities. First of all, unit value of each output and input are obtained at 1960 prices from their 1960 data. The quantities of various output and inputs in different years are then multiplied by their corresponding unit value in 1960. To obtain time-series for value added at 1960 prices, value of raw materials, fuels, etc, at 1960 prices is subtracted from the corresponding value of gross output in sugar industry at 1960 prices.

The data on the number of man-hours worked and the number of direct and contract workers are available for all the years under study in A.S.I. and C.M.I.

The data on book value of capital are published in C.M.I. and A S.I The fixed capital in 1953 and the additional fixed capital in successive years are first deflated by the corresponding years price index as suggested by Dholakia and then added to the previous periods fixed capital to obtain time-series for fixed capital in Sugar Industry.

As there is no direct data on capacity utilisation, it is computed on the basis of actual output as a fraction of maximum output in any year during the sample period. The capacity utilisation thus obtained is multiplied by the corresponding years fixed capital to arrive at adjusted fixed capital for each year.

The data on total amount disbursed by way of wages in Sugar Industry are available in CMI and ASI. The data are divided by the corresponding number of man - hours worked by workers to obtain money wage per man-hour, which are then deflated by index of wage for industrial workers with base 1960-61 = 100 to obtain real wage rate.

LOVE-POEMS OF ROBERT BURNS – A STUDY

E. S. A. RAMANAGANGA, N. SUBRAMANIAN
Department of English and Comparative Literature

There are many significant love poems written by Robert Burns. To make a critical examination of his poetic genius two of his poems of love may be studied. A psychology - oriented analysis of the two specimens warrants a brief reference to the poet's life in view of the fact that most of his works are essentially autobiographical in nature.

Burns had great admiration for the womenfolk and love was his religion. Sometimes sophisticated and unsophisticated external stimulant could inspire the creative writers For example, Housman spontaneously caught little or much of a poem on his walks; Hart Crane tried to evoke the creative process by drink and jazz music; Schiller is reported to have kept a rotting apple in his desk because he found the odour stimulating;[1] so Robert Burns drew his inspiration from the women whom he loved. "Whenever I want to be more than ordinary in song ... I put myself on a regimen of admiring a fine woman"[2] - that is how the poet explains the source of his inspiration. When Burns was sixteen he was inspired by one, Nelly Kirkpatrick; in 1780 he fell in love with Alison Bagbie, daughter of a small farmer. In 1785, Elizabeth Baton bore him an illegitimatie child. In the summer of the same year he became seriously involved with Jean Armour whom he later chose for his wife. In December 1787, he met Mrs. Agnes Leghose and it was a love at first sight. All these clearly show that Burns had no constant love for one particular lady. This is no doubt reflected in his love songs which are mainly centered on 'mutability of love'. It appears as though the poet had a conviction that sexual love can make a poor man feel superior to the rich. Himself a farmer by birth and by occupation at a time when agricultu e proved a total failure, no wonder, Burns with all his appetite for carnal pleasure resorted to sociability and conviviality. Fairchild observes : "Often too, he (Burns) used sexual indulgence as a means of escaping from unpleasant activities, or of relieving his sense of inferiority through acts of conquest and domination."[3] In his autobiographical letter to Dr. John Moore, Burns himself admits his own 'strong appetite for sociability'[4] Critics call this 'appetite' a sure sign of the artistic temperament innate in the poet It would be interesting to note that Burns's very first poem was inspired by a 'bonnie lass'. The poet openly acknowledges this fact in his autobiographical letter.[5] In the Scotland of his day there was a custom of coupling a man and woman together as partners in the labours of harvest. Burns's partner in the field was Nelly Kirkpatrick and inspired by this lady, Burns composed his first poem 'Once I loved a Bonnie Lass'

Normally the feeling of love in a lad who is at the threshhold of adolescence centres on chiefly sex; qualities like innocence and modesty rarely appeal to him. But to Burns

"A gaudy dress and gentle air
may slightly touch the heart,
But it's innocence, and modesty
that polishes the dart"[6]

---

1. Cleanth Brooks : Understanding Poetry, Holt, Rinehart and Winston, New York, 1960. p. 524.
2. Letters of Robert Burns quoted in Crawford : Burns a study of the poems and songs, Oliver & Boyd London, 1963. p. 270.
3. Hoxie Neale Fairchild : Religious Trends in English Poetry (Vol III), Columbia University Press, United States of America, 1956, p. 44.
4. Alan Dent : Burns in his time, Thomas Nelson & Sons, Ltd., London, 1966, p. 12.
5. Quoted in J. G. Lockhart : Life of Robert Burns Everyman's Library London, 1966, p. 12.
6. Burns Poems & Songs, Ed. James Kinsley : Oxford University Press, 1969, p.1 (poem No. 1; stanza No.6)

But this kind of 'pure love' did not, however, perpetuate to be the stock-in-trade in his subsequent poems and songs. His later poems reveal him to be more concerned with sex than with pure love. This transition from 'pure love' to 'erotic love' may be attributed to Burns's association with people like Captain Brown, Mrs Buchan and above all, his own physical appearance - he was very attractive to women, very susceptible and very strongly sexed.

The poet describes what effect his friendship with Captain Brown brought him as a result :

> "but the principal thing which gave my mind a turn was, I formed a bosom-friendship with a young fellow..... He was the only man I ever saw who was greater fool than myself when woman was the presiding star: but he spoke of illicit love with the levity of a sailor, which hitherto I had regarded with horror. Here his friendship did me a mischief.., "[7]

It suggests that hitherto he had been shy with the fair-sex. In regard to the same critical period of Burns's life, his younger brother, Gilbert Burns writes :

> " .... during this time the foundation was laid of certain habits in my brother's character, which afterwards became but too prominent, and which malice and envy have taken delight to enlarge on. Though, when young, he was bashful and awkward in his intercourse with women, yet when he approached manhood, his attachment to their society became very strong and he was constantly the victim of some fair enslaver ...."[8]

For a vivid contemporary description of Burns as he appeared to the Edinburgh gentry one needs to rely on Josiah Walker. Describing the poet's 'dark and luxuriant sensibility' Walker declares that "he Burns indeed is favoured in personal appearance."[9] On another occasion Walker has this notable statement about Burns to make : "In no man is sexuality more powerful or apparent "[10] We may gather from other private letters and memories how admirably Burns behaved in Edinburgh. An observer in Edinburgh, Prof. Dalziel, writes about Burns to a friend of his :

> "We have got a poet in town just now, whom every body is taking notice of - a ploughman from Ayrshire-a man of unquestionable genious. He is a fellow of strong common sense. But he runs the risk of being spoiled by the excessive attention paid him just now by persons of all ranks. I saw him at an assembly t' other night. The Duchess of Gordon and other ladies ofrank took notice of him."[11]

All these statements bear testimony to the handsome personal appearance of the poet.

And, next coming to his much admired song, 'A Red, red rose'. The journal of the poet has the following entry about the song : "I have just put the last hand to a song and I think I may say of it here is a work of mine finished in my very finest style "[12] It is agreed on all hands that Burns is much more read and admired for his songs than for any other group of poems. As Rees observes "it might be said (rather unkindly) that the simple, direct, emotional lyric is now so much a part of pop culture that serious and 'bookish' poets dare not attempt it."[13] The growing popularity of Burn's songs may be due to the enormous simple and conventional similes that they contain. For more than one reason the song 'A Red red rose' is considered to be the best of all his songs. Crawford observes Burns in this song "doing much the same thing as poets have always done with single words, except that here he is dealing with set phrases - the proverbs of passion."[14]

---

7. Op. cit. Lockhart, p: 272
8. Ibid, p.17.
9. Op. cit. Alan Dent, p. 23.
10. Ibid, p. 147.
11. Ibid, p. 153.
12. Ibid, p. 155.
13. R.J. Rees, English Literature (An Introduction to foreign readers), The Macmillan, Madras, 1973, p. 85.
14. Op. cit. Crawford, p. 279.

'A Red, red rose' is a song celebrating the poet's love. Here the poet identifies her physical features with the rose, the melody.

O my luve's like a red, red rose,
That's newly sprung in June;
O my luve's like the melodie
That's sweetly play'd in tune.[15]

'Like a red, red rose' is a simile in which Burns is describing his love for Jean Armour, his wife. Though there is a clear 'Like', a conventional simile-symbol, the emotional intensity is so poignant that it seems to function more like a metaphor (a condensed form of poetic expression. than like a simile. In other words, the identifi) cation made between red rose, melody and Jean Armour is so immediate and spontaneous that 'like' seems to evade the attention from the reader. The poet is able to bring out a unity in different things. For Louis Simpson calls poetry

"a sign of genius since a good metaphor implies an intuitive preception of the similarity in dissimilars"

and says "there seem to be instincts that make us look for similarity in dissimilars, searching for a unity in different things."[16]

Here as well as in other of his love songs, Burns draws generously from Nature for his images Burn's images stand with their empirical manifestations; they do not suggest any mystic or symbolic cannotations. Commenting upon the song, Crawford says,

"In 'A Red, red rose' traditional similes and comparisons perform, on the serious plane, much the same function as that of the proverbs in 'In Simmer, when the Hay was mawn'. But the rose. the melody. the drying seas and melting rocks and sands of the former song are not symbolic in the modern sense of that word; that is, they are not like the flower (Earthly Love), the worm (Corrupt Lust) and the storm of Blake's 'Sick Rose." [17]

The song may be of pure passion devoid of intellectual content, but it serves what the poet considered to be his purpose of appealing to common man - A psychological approach to the song under study will endeavour to shake the common belief (a belief based on the Freudian School but of late losing its ground) that unfulfilled sexual desires in the real life evoke in the imaginary world a sense of satisfaction and that a work of art represents such repressed and unfulfilled sexual desires of the artist.[18]

Burns's poems are generally considered to be full of autobiographical elements. "A Red, red rose' was written in praise of his wife on the occasion of the honeymoon Here he is not pining over an imaginary lady; he sings in praise of one who is before him-his wife. Similarly it was during his brief infatuation with Alison Bagbie that Burns wrote 'And I'll kiss thee yet'. He played the game of love with more than one woman on more than one occasion. Most of his songs are addressed to his various lady-loves and reflect his various moods and experiences in real life. About Burns's Ayrshire love stories, Lockhart says :

"How many lesser romances of this order were evolved and completed during his residence at Mossgiel, it is needless to inquire; that they were many, his songs prove, for in those days he wrote no love-songs on imaginary heroines ...." [19]

It may be concluded that Burns's poems-particularly his love-songs are admired more for their simple language and conventional similes than for their intellectual appeal. In other words there is a great scope for critics to explore his works in depth.

15. Burns's poems and songs, poem no. 453, 11 1-4.

16. Louis Simpson : An Introduction to Poetry, The Macmillan, London, 1968, p. 3.

17. Op. cit. Crawford, p. 280.

18. However the study is not complete. There is still possibilites to undertake a more comprehensive and in-depth study in this aspect in the light of Freud's major works like 'Interpretation of Dreams' and 'Psychology of Everyday life'.

19. Op. cit, Lockhart, p. 55.

"RANKING OF BIOCHEMICAL JOURNALS: ACITATION ANALYSIS STUDY"

By

D. CHANDRAN
Lecturer, Dept. of Library & Information Science
Madurai Kamaraj University

Citation Indexing has become an increasingly useful search tool The present paper enumerates the characteristics and uses of this concept. Based on citation analysis the ranking is made of the ournals in biochemistry. The findings are listed and the ranked list is compared with the previous list of Garfield.

Introduction :

Citation Indexing is a simple and a recent concept It has proved to be an efficient and productive search tool. Citations provided in books, articles, reviews etc usually contain information about the author, title and imprint statement. These citations provide linkages between documents that have common points. From a single paper, one can find a number of related papers with varying degrees of relevance to the original. As the knowledge grows the literature coverage becomes comprehensive and multidisciplinary, the Citation Indexing becomes more meaningful and increasingly useful.

Science Citation Index (SCI) published by the Institute for Scientific Information (ISI), Philadelphia is the first large scale attempt to apply the concept of Citation Indexing for the search of scientific literature. The SCI has now established itself as an important and efficient literature retrieval tool.

Characteristics :

The functional characteristics of a Citation Index may be summarised as:-

1. It focuses our attention to the relationship between scientific events.

2. It gives subject categorisation of published materials. That is, semantically both precise and detailed.

3. It shows the relationship that exist between old and new literature, between individual events at different points in time.

Uses :

1. It improves the utility and relationships of journals whose primary function is to communicate nascent thought.

2 It reveals a number of interesting and useful insights into the network of journals that function as the formal communication medium.

3. It is a tool for the study of journals of science as well as the people and works of science.

4. It is useful to (a) the editors trying to determine their competetive position (b) librarians managing large journal collections (c) infor mation specialists studying the structure of literature (d) sociologists attempting to define the structure of science itself and (e) researchers to identify useful journals.

Need for Ranking :

Readers find it difficult to go through all the recent publications due to the increase in the number of journals that are published, even in specialised fields. The librarians equally feel the difficulty of selecting the journals for their libraries with limited library budget.

The World List of Scientific Periodicals indicates that there is a steady increase in the number of journals publised in general and biochemistry in particular. Further a large number of biochemical articles are being published in General Science periodicals and in journals of allied nature. Consequently the biochemists find themselves lost in this ocean of literature.

The purpose of this study is to prepare a list of biochemical journals, ranked in order of their frequency of citation based on the citations provided in the Annual Review of Biochemistry for the year 1979. The findings will be of use to the specialists in assessing the relative importance of the journals and the librarians in selecting them for their libraries with limited budget.

Methodology :

The source taken for ranking of the biochemical journals is the *Annual Review of Biochemistry*, V. 48, 1979. For this purpose, all the periodical citations found at the end of each article are counted. Each title of the journal cited in the *Annual Review* is carefully entered in a 8″x6″ card. The card is divided into ten units representing ten years (1970 to 1979). Citations prior to 1970 are entered in seperate cards for each title of the journal. The Place of publication is also indicated. Books, theses and other non-periodical publications are not counted for this purpose.

Findings and Conclusion :

Annual Review of Biochemistry, V. 48 has published 33 articles. Each article is provided with a list of references. The number of references varies from article to article.

The total number of citations in the Annual Review is 6 03 The article entitled 'DNA Repair in bacteria and mammalian cells' has quoted the highest of 405 citations against the article 'Three dimensional structure of immunoglobulins' with 53 citations. On an average the number of citations per article is 191.

Following is a list of journals arranged in the descending order of citation frequency. Ranking has been made for the first 25 journals. The listing also gives the place of publication, year of first publication, number of times cited and the percentage of total citations.

Serial No (1)	Title of the journal (2)	Rank (3)	No. of times cited (4)	% of total citations (5)	Year of establishment (6)	Place of publication (7)
1.	J Biol Chem	1	782	12.40	1905	U S
2.	Proc Natl Acad Sci	2	678	10 75		U S
3.	Biochemistry	3	356	5 64	1964	U S
4.	Biochem Biophys Acta	4	337	5 34	1947	Netherlands
5	Eur J Biochem	5	295	4.68	1967	W. Germany
6.	J Mol Biol	6	269	4 26	1959	U K
7.	Nature	7	257	4.07	1869	U K
8.	Biochem Biophys Res Commun	8	209	3 31	1959	U S
9.	FEBS Lett	9	192	3 04	1968	Netherlands
10	Biochem J	10	131	2 07	1906	U K
11.	Cell	11	115	1 82	1974	U K
12.	J Bacteriol	12	108	1 71	1916	U S
13.	Science	13	86	1 36	1883	U S
14.	Ann Rev Biochem	14	76	1 20		U S
15.	Cold Spring Harbor Symp Quant Biol	15	67	1 05		U S
16.	Arch Biochem Biophys	16	55	0 87	1942	U S
17.	Exp Cell Res	17	51	0 80	1950	U S
18.	J Cell Biol	18	48	0.76	1955	U S
19.	Dev Biol	19	43	0 68	1959	U S
20.	Necleic Acids Res	20	40	0 63	1974	U K
21.	Fed Proc	21	33	0.52		U S
22.	J Chem Soc	22	29	0 46	1879	U S
23.	Ann NY Acad Sci	23	24	0 38		U S
24.	Endocrinology	24	23	0 36	1917	U S
25.	J Supramol Struct	24	23	0.36	1972	U S
26.	J Virol	25	20	0.31	1967	U S

Journal of Biological Chemistry published from the United States gets the first rank with a total number of 782 citations. It is closely followed by the *Proceedings of the National Academy of Sciences* with 678 citations. The third place in ranking goes to *Biochemistry*.

Journal of Biochemistry :

Out of 782 citations, 677 citations pertain to the years from 1970 to 1979. Remaining 105 citations are distributed as follows:

Year	*Number of citations*
1960–69	95
1950–59	9
1945	1

The highest number of references is for the year 1977 with 120 citations followed by 1978 with 116 citations.

J BIOL CHEM						Place of Publication			U S
1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
31	43	46	61	67	97	87	120	116	9

The above table indicates a steady rise from 1970 to '75 with a slight drop in 1976. The steep fall in 1979 may be attributed to the coverage of the *Annual Review* itself, as it belongs to the same year. The data reveals that more than 50% of its references cited materials published between 1975-'79.

Year	Percentage of references cited
1975–79	54.85
1970–74	31.74
Before 1970	13.41

Proceedings of the National Academy of Sciences:

It has been cited 678 times and gets the II ranking. 622 citations ie. 91 74% of the citations pertain to the years 1970 to 79 The *Proceedings* has also cited an article published in 1936. Similar to that of the *Journal of Biological Chemistry*, it has cited the highest for the year 1977 with 138 citations followed by 1978 with 125 citations. The year wise citations for the *Proceedings* is given below:

PROC NAT ACAD SCI						Place of Publication: US			
1970	71	72	73	74	75	76	77	78	79
11	20	38	48	65	77	87	138	125	13

Annual Review of Biochemistry:

It cites itself for a total of 76 times. It gets the 14th place in the ranking. The self citing rate is calculated as

$$\frac{76}{6303} \times 100 = 1.21$$

Place of Publication:

Out of the 25 journals ranked, the United States tops the list in countrywise ranking. It is followed by the United Kingdom. The following table indicates the ranking for the first 25 journals ranked in the list.

USA	—	18
UK	—	5
Netherlands	—	2

Comparison with Previous List:

The present ranking list is compared with that of Garfield's list (1974). The following table indicates the position of each ranked journal.

Sl. No.	Title of the Journal	Garfield's list (Ranking)	Present List (Ranking)
1	J Biol Chem	1	1
2	Proc Natl Acad Sci	5	2
3	Biochemistry	2	3
4	Biochem Biophys Acta	4	4
5	Eur J Biochem	34	5
6	J Mol Biol	7	6
7	Nature	10	7
8	Buochem Biophys Res Commun	9	8
9	Febs lett	—	9
10	Biochem J	6	10
11	Cell	—	11
12	J Bacteriol	30	12
13	Science	12	13
14	Ann Rev Biochem	19	14
15	Cold Spring Habbor Symp Quant Biol	29	15
16	Arch Biochem Biophys	8	16
17	Exp Cell Res	—	17
18	J Cell Biol	35	18
19	Dev Biol	—	19
20	Nucleic Acids Res	—	20
21	Fed Proc	11	21
22	J Am Chem Soc	3	22
23	Ann Ny Acad Sci	18	23
24	Endocrinology	47	24
25	J Supramol Struct	—	24
26	J Virol	—	25

Analysis of these two lists, namely the Garfield's list and the present list reveals certain interesting observations. The *J Biol Chem* continues to maintain its first position in both the lists. In other words, the biochemists continue to publish more number of articles in the *J Biol Chem*. *Biochemistry* which was in the 2nd position in Garfield's list gets the 3rd place and in its position *PROC NATL ACAD SCI* has been placed. The third ranked *J AM CHEM SOC* in Garfield's list gets the 22nd ranking in the present list. *Biochem Biophys Acta* maintains its 4th place in both the lists. In general there is not much variation in the first ten ranking in both the lists except in the case of *Eur J Biochem* which was ranked in the 34th place in Garfield's, pushed up to the

5th rank and the 3rd ranked *J Am Chem Soc* to the 22nd position in the present list.

It is observed from this study that the number of Indian journals cited is negligible It suggests that the Indian scientists prefer to publish in foreign journals than publishing them in our country. Further in the ranking of journals according to the place of publication, countries such as Germany, Japan, France etc do not figure in the list.

The article 'DNA repair in Bacteria and Mammalian cells' has cited 405 citations and on an averagc 191 citations per article is calculated. It looks that the number of pages of citations may be equal to the number of pages devoted for the articles! A few journals cited are general in nature and they do not pertain to the field of Biochemistry or its allied subjects.

This study on the ranking of Biochemical journals based on the citation analysis will be of great help to the librarians to select and procure the journals for their libraries with the limited budget. The scientists and the researchers will be benefited in identifying the most commonly cited biochemical journals for their research work. This work will also help them to publish their own works in the frequently cited journals.

Since we observe certain variations in the ranking of journals (however slight the change in ranks may be) it is considered essential that ranking studies should be carried out periodically at close intervals, say 3 years over a period of 12 to 15 years and the final observations may be analysed for establishing stability in the ranks of important periodicals in any branch of sciences.

References :

1. ANNUAL REVIEW of biochemistry, V. 48. California. Annual Review Inc, 1979.
2. GARFIELD, Eugene. Citation indexing: Its theory and application in science, technology and humanities. New York, John Wiley, 1979.
3. SENGUPTA, I. N. Growth of biochemical literature. *Nature* V 244, 1973, pp. 75-6, 118.

Series B

Sciences

11.	A R. Meenakshi	On Idempotent inverses of a Matrix	53
12.	K. Ramachandran & T. M. Haridasan	Role of angular forces in the dynamics of Gallium Phosphide	57
13.	V Kannan & S. Krishnaswamy	Limnological study of ponds of Madurai Kamaraj University Campus	65
14.	Samuel Paulraj & N. Sukumaran	Studies on certain Hydrobiological Changes in sewage-fed fish culture ponds	69

ON IDEMPOTENT INVERSES OF A MATRIX

AR. MEENAKSHI
Department of Mathematics, Annamalai University, Annamalainagar - 608 101.

ABSTRACT

Let λ be any nonemty subset of $\{1, 2, 3, 4,\}$ and consider the matrix equations (1) $AXA = A$, (2) $XAX = X$, (3) $AH = (AX)^*$ and (4) $XA = (XA)^*$ where A is an $m \times n$ complex matrix. By a λ inverse of A is meant a solution of the equations (i), $i \in \lambda$. We have given conditions for which every λ inverse is idempotent. A set of necessary and sufficient conditions are obtained for every λ inverse to be hermitian idempotent where $\lambda = \{2, 3\}$, $\{2, 4\}$ & $\{2, 3, 4\}$.

Introduction :

Throughout we consider square matrices over the complex field. Let $C^{n \times n}$ denote the set of all complex matrices of order n. For a subset S of $C^{n \times n}$ let I (S), H(S) and HI (S) denote respectively the set of all idempotents, hermitian, and hermitian idempotent matrices in S. Let A be an m x n complex matrix and consider the Penrose [3] equations : (1) $AXA = A$, (2) $XAX = X$, (3) $AX = (AX)^*$ and (4) $XA = (XA)^*$ where X is an n x m matrix and * denotes the conjugate transpose. Let λ be any nonempty subset of $\{1, 2, 3, 4\}$. X is said to be a λ inverse of A if X satisfies equation (i) for each $i \in \lambda$. In particular the $\{1, 2, 3, 4\}$ inverse of A is unique and is denoted by A^+. If A is square and non-singular then $A^+ = A^{-1}$, otherwise A has many λ inverses for each $\lambda \neq \{1, 2, 3, 4\}$. Let A (λ) denote the set of all λ inverses of A.

It is well known that ([1], p. 54) if A is an idempotent matrix and for $X \in A\{2\}$, $R(X) \subseteq R(A)$ (where $R(A) = \{Ax / x \in C^{n \times 1}\}$ denotes the range space of A) then X is idempotent. Here we have obtained a set of conditions for $A\{2\} = I(A\{2\})$. It has been proved in [1], p. 73 that if A is hermitian idempotent then $X \in A\{2,3,4\}$ is also hermitian idempotent and $R(X) \subseteq R(A)$ Here we have shown that the converse is true and have obtained a set of necessary and sufficient conditions for $A(\lambda) = HI(A(\lambda))$ where $\lambda = \{2,3\}$, $\{2,4\}$ and $\{2,3,4\}$. We have given some properties of the set of all A for which $A\{2\} = HI(A(\{2\})$.

Results :

We shall give a set of conditions for which $A\{2\} = I(A\{2\})$ for any $A \in C^{n \times n}$.

Theorem 1 :

Let $A \in C^{n \times n}$. If any one of the following statement holds then $A\{2\} = I(A\{2\}$,

(i) $A\{2\} \cap X\{2\} = (AX)\{2\}$ for every $X \in A\{2\}$.

(ii) $I(A\{2\}) \cap I(X\{2\}) = I(AX)\{2\})$ for every $X \in A\{2\}$.

(iii) A is idempotent and $R(X) \subseteq R(A)$ for every $X \in A\{2)$.

Proof :

(i) $\Rightarrow$ (ii) is clear from $I(S) \subseteq S$ for any set $S \subseteq C^{n \times n}$. We will show that (ii) $\Rightarrow A\{2\} = I(A\{2\})$. Let X be any element in A {2}, then $X = XAX$. $(AX) = (AX)(AX) = (AX)(AX)(AX)$. Thus (AX) is idempotent and $(AX) \in (AX)\{2\}$. Therefore $(AX) \in I((AX)\{2\})$. Since $I((AX)\{2\}) = I(A\{2\}) \cap I(X\{2\})$, $(AX) \in I(X\{2\})$. Hence $(AX) = (AX)\, X\, (AX) \Rightarrow XAX = (XAX)(XAX) \Rightarrow X = X^2$. Thus X is idempotent {2} inverse of A, and $X \in I(A\{2\}$. Since X is arbitrary we have $A\{2\} \subseteq I(A\{2\})$. From the definition it is clear that

$I(A\{2\}) \subseteq A\{2\}$. Thus $A\{2\} = I(A\{2\})$. (iii) $\Rightarrow A\{2\} = I(A\{2\})$ is given in ([1], p. 54). Hence the theorem.

Remark :

If A satisfies any one of the above three conditions in the theorem then $A\{2\} \subseteq I$ the set of all idempotent matrices in $C^{n \times n}$. Since $I_n\{2\}$ consists of all idempotent matrices of order n ([1], p.54), $A\{2\} = I$ if and only if A is the identify matrix.

Remark :

The necessity of the condition of A in (iii) can be seen by the following example.

$A = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ is not idempotent.

$X = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \in A\{2\}$, $R(X)=R(A)$ but X is not idempotent. Hence $A\{2\} \neq I(A\{2\})$.

Theorem 2 :

Let $A \in C^{n \times n}$ and $A\{2\} = HI(A\{2\})$. Then A is hermitian idempotent and $R(X) \subseteq R(A)$ for every $X \in A\{2\}$.

Proof :

Since $A^+ \in A\{2\} = HI(A\{2\})$, A^+ is hermitian idempotent. Hence (by Ex. 19, p. 24 [1]) $(A^+)^+ = A^+ \Rightarrow A = A^+$. Thus A is hermitian idempotent. Let $X \in A\{2\}$; X can be represented as $X = (EAF)^+$, for suitable hermitian idempotents E and F ([2], Quoted in [1] p. 69). Since X is hermitian idempotent; $X = X^+$ and $X = EAF$. Therefore $R(X) \subseteq R(EA) = R(A)$ for every $X \in A\{2\}$. Hence the theorem.

Remark :

For $A \in C^{n \times n}$, $A\{2\} = HI(A\{2\}) \Rightarrow A$ is hermitian idempotent and $R(X) \subseteq R(A)$ for every $X \in A\{2\} \Rightarrow A$ is idempotent and $R(X) \subseteq R(A)$ for every $X \in A\{2\} \Rightarrow A\{2\} = I(A\{2\})$. However the converse of the above theorem need not be true. For, let $A = I_n$ then, $I_n\{2\}$ consists of all idempotent matrices of order n but all of them are not hermitian.

Remark :

If $A\{2\} = HI(A\{2\})$ then, A is hermitian idempotent and $X \in A\{2\}$ is hermitian idempotent. Since $R(X) \subseteq R(A)$, $AX = X$ is also hermitian idempotent. Hence $AX = XA = X$, for every $X \in A\{2\}$, using this we shall study the properties of those matrices whose $\{2\}$ inverses are all hermitian idempotent.

Corollary 1 :

Let $A \in {}^{n \times n}$ and $A\{2\} = HI(A\{2\})$. Then $A(\lambda)$ contains the single element A for $\lambda = \{1, 2\}$, $\{1, 2, 3\}$, $\{1, 2, 4\}$, and $\{1, 2, 3, 4\}$.

Proof :

Since $A\{1, 2\} \subseteq A\{2\}$, $AX = XA = X$ for every $X \in A\{1, 2\}$. Then, $A = A(XA) = AX = X$. Thus $X = A$ for every $X \in A\{1, 2\}$. Since $A\{1, 2, 3, 4\} \subseteq A\{1, 2, 3\} \subseteq A\{1, 2\}$ and $A\{1, 2, 3, 4\} \subseteq A\{1, 2, 4\} \subseteq A\{1, 2\}$ all of them are identical and contains the single element A.

Remark :

However $A(\lambda)$ containing the single element A for $\lambda = \{1, 2, 3, 4\}$ need not imply that $A\{2\} = HI(A\{2\})$. For example,

$A = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$ is hermitian idempotent and $A^+ = A$.

$X = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} \in A\{2\}$ is not idempotent.

$A\{2\} \neq HI(A\{2\})$.

Remark :

For any nonsingular matrix A, $A\{1\}$ consists of the single element A^{-1}. Hence $A\{1,2\} = A\{1\} \cap A\{2\}$ also consists of the single element A^{-1}. For any nonsingular nil-potent matrix A $(A^2 = I)$, $A\{1,2\}$ contains the only element A, but every $\{2\}$ inverse of a nil-potent matrix need not be idempotent.

Example :

$A = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ is a nil-potent matrix.

$X = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \in A\{2\}$ is not idempotent

Thus $A\{2\} \neq I(A\{2\})$.

Next we shall give a set of necessary and sufficient conditions for $A(\lambda) = HI(A(\lambda))$ where $\lambda = \{2,3,4\}$, $\{2,3\}$, and $\{2,4\}$.

Theorem 3 :

Let $A \in C^{n \times n}$ and $\lambda = \{2,3,4\}$. The following are equivalent.

(i) $A(\lambda) \cap X(\lambda) = (AX)(\lambda)$ for every $X \in A(\lambda)$.

(ii) $I(A(\lambda)) \cap I(X(\lambda)) = I((AX)(\lambda))$ for every $X \in A(\lambda)$.

(iii) $HI(A(\lambda)) \cap HI(X(\lambda)) = HI(AX)(\lambda))$ for every $X \in A(\lambda)$.

(iv) $A(\lambda) = HI(A(\lambda))$

(v) A is hermitian idempotent and $R(X) \subseteq R(A)$ for every $X \in A(\lambda)$.

Proof :

(i) $\Rightarrow$ (ii) $\Rightarrow$ (iii) are clear from the definitions of $I(S)$ and $HI(S)$ for any subset $S \subseteq C^{n \times n}$.

(iii) $\Rightarrow$ (iv) : Let X be any element in $A\{2,3,4\}$. Then, $X = XAX$, AX and XA are hermitian. We can easily see that $(AX) \in HI((AX)\{2,3,4\})$. Therefore $AX = (AX)X(AX)$, $X(AX)$ and $(AX)X$ are hermitian. Thus $X^2 = X$ and X is hermitian. Since X is arbitrary, $A(\lambda) \subseteq HI(A(\lambda))$. Thus we have $A(\lambda) = HI(A(\lambda))$, and (iv) holds.

(iv) $\Rightarrow$ (v) : Since $A^+ \in A(\lambda) = HI(A(\lambda))$, A^+ is hermitian idempotent. $A = (A^+)^+ = A^+$ is also hermitian idempotent. For every $X \in A(\lambda) = HI(A(\lambda)$ $X = XAX$, AX, XA are all hermitian idempotent. Hence we get, $AX = XA = X$ which implies $R(X) \subseteq R(A)$ for every $X \in A(\lambda)$. Thus (v) holds.

(v) $\Rightarrow$ (i) : Since A is hermitian idempotent and $R(X) \subseteq R(A)$ for every $X \in A\{2,3,4\}$ we get $AX = X$. Hence $(AX)\{2,3,4\} = X\{2,3,4\}$. To prove (i) it is enough if we show that $X\{2,3,4\} \subseteq A\{2,3,4\}$, for every $X \in A\{2,3,4\}$. Since $X = AX$, X is hermitian. Now A, X and (AX) are hermitian, hence $AX = XA = X$ for every $X \in A\{2,3,4\}$. Let $Y \in X\{2,3,4\}$. Then, $Y = YXY$, XY and YX are hermitian. Since X is hermitian idempotent, the products $X(XY)$ and $(YX)X$ are hermitian. Hence X commutes with both YX and XY.

$$YX = (YX)X = X(YX) = (XY)X = X(XY) = XY$$

$$Y = YXY = (YX)(XY) = (YX)(YX) = YX.$$

Thus $Y = XY = YX$ is hermitian idempotent.

$Y = YXY = (YX)A(XY) = YAY \Rightarrow Y \in HI(A\{2\})$

Further, $AY = A(XY) = (AX)Y = XY = Y$

$$YA = (YX)A = Y(XA) = YX = Y$$

Thus $AY = YA = Y$ and Y is hermitian$\Rightarrow Y \in A\{2,3,4\}$.

Since Y is arbitrary, $X\{2,3,4\} \subseteq A\{2,3,4\}$, and (i) holds.

The proof is complete.

Remark :

Similar results can be obtained for $\lambda = \{2,3\}$ and $\{2,4\}$. Thus we have derived set of necessary and sufficient conditions for $A(\lambda) = HI(A(\lambda))$.

Corollary 2 :

Let $A \in C^{n \times n}$. Then, $A\{2\} = HI(A(\{2\}) \leftrightarrow A$ is hermitian idempotent and $A\{2,3,4\} = A\{2\}$.

Proof

Since $A\{2\} = HI(A\{2\})$ by theorem 2, A is hermitian idempotent. Let X be an arbitrary element in $A\{2\} = HI(A\{2\})$. Then, $AX = XA = X$ and X hermitian implies both AX and XA are hermitian. Hence $X \in A\{2,3,4\}$, which implies $A\{2\} \subseteq A\{2,3,4\}$. Thus we have $A\{2,3,4\} = A\{2\}$. Conversely, suppose A is hermitian idempotent, then $X \in A\{2,3,4\}$ is also hermitian idempotent and $R(X) \subseteq R(A)$ ([1], p.73). Thus $A\{2,3,4\} = HI(A\{2,3,4\})$, and it is given that $A\{2\} = A\{2,3,4\}$ Therefore $A\{2\} = HI(A\{2\})$.

Remark :

If $A\{2\} = HI(A\{2\})$ then $A\{2\}$, $A\{2,3\}$, $A\{2,4\}$, and $A\{2,3,4\}$ are all identical.

References :

1. Adi Ben-Israel and Thomas N. E. Greville 1974 Generalized Inverse: Theory and Applications, John Wiley & Sons, New York,

2. Greville, T.N.E. 1974 Solutions of the matrix equations XAX = X and relations between oblique and orthogonal projectors, SIAM. J. Appl. Math. 26 (1974)

3. Penrose, R. 1955 A generalised inverse for matrices, Proc. Cambridge Philos. Soc. 51 pp. 406-413.

ROLE OF ANGULAR FORCES IN THE DYNAMICS OF GALLIUM PHOSPHIDE

K. RAMACHANDRAN AND T.M. HARIDASAN
School of Physics, Madurai Kamaraj University, Madurai - 625 021.

ABSTRACT

The lattice dynamical properties of Gallium phosphide are calculated employing the rigid ion model incorporating the angular forces. The results are compared with those of the earliar lattice dynamical models employing only two body interactions and also with the experimental results.

Introduction :

Several investigations have been carried out to study the lattice dynamics of Group III-V compounds during the last 20 years, of which GaAs and GaP have been extensively studied both experimentally and theoretically (Dolling et al 1963, Klienman et al 1960, Johnson 1965). However the Information on the force field in these materials is not that clear even today. Much of the theoretical studies on the force field in these materials started from the work of Banerjee and Varshni (1969) who had developed the rigid ion model for III-V semiconductors. Eventhough the previous workers failed in their attempts to show the merit of the rigid ion model for the phonon spectrum in these crystals, these authors (Banerjee and Varshni) showed that this model indeed gives a fairly good description of the over all nature of the phonon spectrum. Govindarajan (1971) studied the dynamics of GaAs with the help of a modified rigid ion model but the agreement with the experimental phonon dispersion curves was not satisfactory. Sullivan et al (1963) had worked out the lattice dynamics of these compounds on a shell model in a conventional way by taking long wavelength phonon frequencies and elastic constants to fit the force constants. In the least squares fit up, they found that even four to five different sets of parameters could explain the dispersion relation modestly within the same range of accuracy. It amounts to say that there was no unique set of parameters within a shell model which was able to explain the phonon dispersion relation fairly well. Another similar physically realistic model as in the line of shell model, namely deformation dipole model, when applied to these III-V compounds by Kunc et al (1975) also was found to be not very successful. When these shell model and deformation dipole models could explain very well the lattice dynamics of alkali halides and elemental semiconductors, it is rather surprising that it could not do so with these compounds. Yarnell et al (1968) had measured the phonon dispersion of GaP by neutron scattering technique and to explainit theoretically they fitted to a shell model by taking almost all the frequencies into account in the least square fit and evaluated the parameters, a few of which finally yielded unrealistic and unphysical values. For example, the short range forces are seen to be some what stronger in gallium phosphide. Perhaps the most interesting feature of the parameter set for gallium phosphide is the sign of the ionic charge Z, which indicates that the phosphorous atom has a +ve charge and the gallium atom has −ve charge. At first glance, one might have expected the Group V atom to be negative, rather than the Group III. However if one considers the bonding to be primarily covalent, each atom might be expected to have four electrons. This would result in the Group III atom having an extra electron and hence a negative charge. Another

difficulty with such highly sophisticated models is that the number of variable parameters becomes very large and hence the fitted values of these parameters have little significance. The fitting in such a case becomes rather artificial and the uniqueness of the fit is completely lost.

So it is worth considering to look at the lattice dynamics from a new angle.

Recently the analysis of the Brout sum rule of some III-V compounds by Marimuthu (1977) has revealed the failure of the Brout sum rule and hence the existence of trace variable forces in these partly covalent semiconductors.

The deviation from Brontsum rule may be due to

(a) the existence of like neighbour interaction
(b) anharmonicity and
(c) the many body forces.

(a) The interaction among like neighbour, though present perhaps would be relatively small in magnitude since they are situated atleast as second and still further neighbours.

(b) Some aspects of anharmonicity for Gallium phosphide is carefully analysed by Klienman (1960). However a realistic study of anharmonicity is more involved until a satisfactory harmonic model is available

(c) So we shall concentrate on the first and third aspect namely, many body forces whose contribution however is not investigated so far in detail for gallium phosphide. The simplest of such three body forces one can think of, is the angular forces as discussed by Clark et al (1964). The role of such angular forces in the dynamics of gallium phosphide is investigated in this work.

Details of the model :

The harmonic forces employed in the various models which we treatin lattice dynamics can be classified into several categories. The force most commonly used is 'central force'. This is assumed to act only along the line joining two neighbours and is in this sense a 'radial force'. A second type of force is one which depends on the angle which the line joining the moving atoms makes with the equilibrium position of the line, and this type of forces are referred as 'angular forces'.

Jules Delauney (1959) has worked out the equation of motion for diamond type lattice with angular forces. But while he has introduced the angular forces, no provisions have been made to exclude forces associated with rigid body rotations.

Later Clark et al (1964) have introduced the angular forces for a body centered crystal which eliminated effects due to rigid body rotations and we have taken this type of forces (CGW) for our present calculations.

Gallium phosphide is a zinc blende type crystal, the structure of which is shown in Fig : 1.

For the non central forces examined here it is assumed that a change in angle is related to a change in potential energy by a Hook's law force constant. If V_A is the potential energy and $\partial \phi$ a change in angle one obtains

$$V_A = \tfrac{1}{2}\sigma (\partial \phi)^2$$

Where σ is the force constant. In this treatment two types of angles are considered.

Let σ_1 be the force constant associated with first neighbours subtending an angle ϕ_1 and σ_2 that of second neighbours and angle ϕ_2. The expansion of the potential energy is straight forward and the total contribution from the angles considered results in a force on the atom of interest. This takes care of the rotational invariance.

The coupling parameters for the short range forces in the Kellarman's notations are given in units of $\frac{e^2}{2v}$.

$$\begin{bmatrix} 1 & 1 \\ x & 1 \end{bmatrix} = \frac{e^2}{2v}\Big[\frac{4}{3}\Big\{(A + 2B) + 4(A_1 + 2B_1) + 14\sigma_1 + 14\sigma_2\Big\} - (2A_1 + 2B_1 + \sigma_1)\cos\pi q_x(\cos\pi q_y + \cos\pi q_z) + (4\sigma_1 + 2\sigma_2 - 4B_1)\cos\pi q_x \cos\pi q_z\Big] \quad (1)$$

$$\begin{bmatrix} 1 & 1 \\ x & y \end{bmatrix} = \frac{e^2}{2v} \left[\left\{ 2(A_1 - B_1) + \sigma_1 \right\} \sin\pi q_x \sin\pi q_y + 2(\sigma_1 + \sigma_2) \sin\pi q_z (\cos\pi q_x + \cos\pi q_y) \right] \quad (2)$$

$$\begin{bmatrix} 1 & 2 \\ x & x \end{bmatrix} = -\frac{e^2}{2v} \left[\frac{4}{3}(A+2B) + 16\sigma_1 + 16\sigma_2 \right]$$

$$\left[\cos(\pi q_x/2) \cos(\pi q_y/2) \cos(\pi q_z/2) - i \sin(\pi q_x/2) \sin(\pi q_y/2) \sin(\pi q_z/2 \right] \quad (3)$$

$$\begin{bmatrix} 1 & 2 \\ x & y \end{bmatrix} = \frac{e^2}{v} \left[\frac{4}{3}(A\text{-}B)\text{-}8\sigma_1 \right] \left[\sin(\pi q_x/2) \sin(\pi q_y/2) \cos(\pi q_z/2) - i \cos(\pi q_x/2) \cos(\pi q_y/2) \sin(\pi q_z/2) \right] \quad (4)$$

The other coefficients can be obtained by the cyclic permutation of x, y, z.

Here A and B are Kellerman parameters for (Ga - P, interaction (first neighbours); A_1 and B_1 correspond to Ga-Ga interaction (second neighbours) and A_2 and B_2 correspond to (P-P) interaction (second neighbour).

The electrostatic part of the coupling coefficients for the crystals can be obtained from the available data computed on the basis of Ewald transformation for a general zinc blende structure. The Kellerman's parameters B and B_1 are neclected in the first approximation as $|B| \ll |A|$ and $|B_1| \ll |A_1|$. This makes the independent parameters to be obtained as A, A_1, σ_1 and σ_2 which is turn can be obtained from the experimental data on C_{11}, C_{12}, ω_{LO} and ω_{TO} at $q = 0$.

With these, the dynamical matrix $D\begin{bmatrix} q \\ kk^1 \end{bmatrix}$ can be constructed as

$$D_{\alpha\beta}\begin{bmatrix} q \\ kk^1 \end{bmatrix} = \begin{bmatrix} kk^1 \\ \alpha\beta \end{bmatrix}^{S.R} + \begin{bmatrix} kk^1 \\ \alpha\beta \end{bmatrix}^{L.R} \quad (5)$$

(S.R and L.R denote the short and long range part). Diagonalisation of this dynamical matrix yields the phonon frequencies and their polarisation vectors for any wave vector q.

Fixing the parameters :

The force constants are fixed from the following equations (Ramachandran and Haridasan, 1979a)

$$C_{11} = \left[\frac{(A + 2B}{6} + 3\sigma_1 + 2\sigma_2 + 2A_1 + 2B_1 + 0.24762Z^2) \right] \frac{e^2}{2vr_0} \quad (6)$$

$$C_{12} = \left[\frac{A-4B}{6} + A_1 + 5B_1 - \frac{3}{2}\sigma_1 - \sigma_2 - 2.6469Z^2 \right] \frac{e^2}{2vr_0} \quad (7)$$

$$\mu\omega^2_{LO} = \left[\frac{1}{3}(A + 2B)^2 + 8\sigma_1 + 8\sigma_2 + \frac{8}{3}\pi Z^2 \right] \frac{e^2}{v} \quad (8)$$

$$\mu\omega^2_{TO} = \left[\frac{1}{3}(A + 2B)^2 + 8\sigma_1 + 8\sigma_2 - \frac{4}{3}\pi Z^2 \right] \frac{e^2}{v} \quad (9)$$

Further one gets at X point

$$\frac{2}{3}(A + 2B) + 4A_1 + 4B_1 + 10\sigma_1 + 8\sigma_2 = \frac{m_1 \omega^2_{IA}(X)\, v}{e^2} - 4\ 3366Z^2 \quad (10)$$

$$\frac{2}{3}(A + 2B) + 4A_2 + 4B_2 + 10\sigma_1 + 8\sigma_2 = \frac{m_2\omega^2_{LO}(X)\, v}{e^2} - 4.3366Z^2 \quad (11)$$

From equations (8) and (9), the value of Z^2 and hence the effective charge was determined.

Pandey and Dayal (1974) when working on the angular force model of CuBr and CuI have reported that even a change by 50% in Z doesn't change the dispersion relation very much and so they conveniently have chosen for Z the value reported by Philips (1970). But here we have arrived at a value of Z = .56 from the above equations which is very near to the value reported by Klienman (1960) from his experimental observations of phonons.

The above equations can be modified by assuming some reasonable assumptions. B and B_1 are neglected as a first approximation as $|B| << |A|$ and $|B_1| << |A_1|$ from an experience on other solids. In equations (6) to (11) we have employed $A_2 = A_1$ and $B_2 = B_1$ for simplicity. Justifications for this come from the fact that for obtaining the value of $\omega_{LO}(X)$, the expression is the same as that of $\omega_{LA}(X)$ execpt tthat A_1 and B_1 are replaced by A_2 and B_2 (See equations (10) and (11)). So it follows from the above assumptions

$$\omega^2_{LA}(X)\, m_1 = \omega^2_{LO}(X)\, m_2$$

This relation is fairly well satisfied in many III-V semiconductors.

Thus these assumptions reduce the number of indepent parameters to four, namely A, A_1, σ_1 and σ_2. Now the equations (6), (7), (8) and (10) become

$$\frac{A}{6} + 3\sigma_1 + 2\sigma_2 + 2A_1 = \left[\frac{2vr_0}{e^2} C_{11} - 0.24762\, Z^2\right] = P$$

$$\frac{A}{6} + A_1 - \frac{3}{2}\sigma_1 - \sigma_2 = \left[\frac{2vr_0}{e^2} C_{12} + 2.6469\, Z^2\right] = Q$$

$$\frac{4A}{6} + 8\sigma_1 + 8\sigma_2 = \left[\frac{\mu\omega^2_{LO}V}{e^2} - \frac{8}{3}\pi Z^2\right] = R$$

$$\frac{4A}{6} + 4A_1 + 10\sigma_1 + 8\sigma_2 = \left[\frac{M_2\omega^2_{LA}V}{e^2} - 4.3366\, Z^2\right) = S$$

These equations are seen not to be independent equations, but give a relation

$$4P = 2S - R$$

Because of this we have only three independent equations. Accordingly we further assume that $\sigma_1 + \sigma_2 = 2A_1$ which says that the sum total of these angular forces is of the same order as the first set of like neighbour central interactions In such a situation

$$A = 6Q + 3P - \frac{3}{4}R \qquad (12)$$

$$A_1 = (3/32)\, R - \frac{Q}{4} - \left[\frac{P}{8}\right] \qquad (13)$$

$$\sigma_1 = (5/4)\, P + (1/2)\, Q - (7/16)\, R \qquad (14)$$

$$\sigma_2 = (5/8)\, R - Q - (3/2)P \qquad (15)$$

It is to be noted that the quantities P, Q, R and S are purely experimental quantities which obey reasonably the relation $4P = 2S - R$. This indicates therefore that the model and the asumptions we have used in fixing the parameters are physically sound to a reasonablel extent. In these respects, the parameters and their methods of determination are quite different from those used by Pandey and Dayal.

Application to Gap :

The experimental values of elastic constants for GaP were collected from the work of Yamada (1976) which are

$C_{11} = 14.11 \pm 0.38 \times 10^{11}$ dynes/sqcm
$C_{12} = 6.26 \pm 0.25 \times 10^{11}$,,
$C_{44} = 7.03 \pm 0.12 \times 10^{11}$,,

The relation $4P = 2S - R$ is verified first and it is seen that the agreement is good. Then we proceeded further to work out the lattice dynamics of GaP in this modified angular force model. The force constants A, A_1, are evaluated using the relations given earlier. The values of these parameters are given in Table 1.

TABLE 1 :

Input data	*Force constant x 10^{-4}*
a = 5.4505 A°	A = 15.343 dynes/cm
$C_{11} = 14.11 \pm 0.38 \times 10^{11}$ dynes/sqcm	$A_1 = -2.552$ dynes/cm
$C_{12} = 6.26 \pm 0.25 \times 10^{11}$ dynes/sqcm	$\sigma_1 = 6.495$ dynes/cm
$\omega_{LO}(\Gamma) = 7.5 \times 10^{13}$ sec^{-1}	$\sigma_2 = 9.181$ dynes/cm
$\omega_{TO}(\Gamma) = 6.8 \times 10^{13}$ sec^{-1}	
$\omega_{LA}(x) = 4.7 \times 10^{13}$ sec^{-1}	
Z = 0.58	

With these parameters the dynamical matrix was constructed for 48 wave vectors which by symmetry generated 1000 equivalent points. We thereby get the eigen frequencies and eigen vectors for 1000 points by diagonalising the dynamical matrix

(i) Dispersion relation :

The dispersion relation i.e. ωvs q for GaP was drawn in the three higher symmetry directions (100), (110) and (111) along with the experimental observations of Klienman and Spitzer (1960). For comparison the results of Banerjee and Varshni in the rigid ion model were also plotted in the same graph. At the time of their calculations, for III V compounds, except GaAs, the available experimental data were limited and so they compared their calculation only with the zone center and edge frequencies. Even at those points the agreement is not that encouraging for gallium phosphide.

But our present calculations explain fairly well the experimental observations especially with regard to the longitudinal modes. The small deviation in acoustic modes is due to the fact that the numerical values of phonon frequencies of acoustic modes are very small which indicates large amount of cancellation of force fields present (Martin, 1969)

One may argue that even our present results do not show remarkable agreement with the experimental results on phonon dispersion. The aim of the present calculation, however is rather to see how far the inclusion of angular forces would improve the situation, than make a point to point comparision with the experiment.

Yarnell et al (1968) have worked out the dispersion relation and got the shell model parameters from a least squares analysis of almost all the experimental data. Even such a sophistigated model with more than 14 parameters could not explain very well the dispersion relation.

In such a context it is very much gratifying to see this present model invoking the idea of angular forces having only four parameters whose determination needed only very limited number of phonon frequencies, shows fairly good agreement with the experimental phonon dispersion. Thus even though the present model looks less desirable from the point of view of interpolation of phonon frequencies at intermediate phonon vectors, it is indeed a more desirable model in explaining the force field in this crystal without bringing any apparently unrealistic value for any of the parameters used.

(ii) Frequency distribution and specific heat :

The next step to look at the overall desirability of the present simple model is to calculate a few other thermodynamic properties for which experimental results are available, such as the specific heat. These calculations need the frequency distribution.

The normal modes computed earlier are properly weighted taking into account the multiplicity of wave vector points giving 6000 phonons. Taking an interval of $\Delta\omega = 0.02 \times 10^{13}$ sec^{-1} along the X-axis and the corresponding number of phonons between ω and $\omega + d\omega$ along the Y-axis, a histogram is drawn which is smothened to give the frequency distribution. As expected one finds a dominant peak near ω_{TO} as $q \to 0$.

Having drawn this phonon spectrum, we are now in a position to compute the specific heats at various temperatures using the theory of specific heats (Reissland, 1973).

$$\frac{C_v}{3R} = \frac{\int \frac{g(\omega)\, y^2 \exp y}{(\exp y - 1)^2} d\omega}{\int g(\omega)\, d\omega}$$

where $y = (h\omega/kT)$ and $g(\omega)$ is the number of phonons between ω and $\omega + d\omega$.

The Debye temperatures corresponding to these C_v's are found out using the tables of Gopal (1966) and a graph of θ_D vs T is given in fig : 4 along with the experimental points.

We could see a marked improvement over Banerjee and Varshni's calculations as our curve is very much near to the experimental, eventhough both the models could reproduce the experimental results only in the same range of accuracy.

(iii) Phonon moments :

Employing the frequency distribution spectrum, we can also calculate various physical properties

such as the Debye Waller factor, zero point energy, geometric mean frequency etc. Another way of looking at the thermal properties from the phonon moments. The nth moment of the phonon spectra can be defined as

$$\mu_n = \frac{\int \omega^n \, g(\omega) \, d\omega}{\int g(\omega) \, d\omega}$$

The modified moments can be defined as

$$\omega_D(n) = \left[\frac{n+3}{3} \mu_n \right]^{\frac{1}{n}}$$

These moments ω_D (n) define the corresponding Debye frequency having an nth moment as obtained from the actual phonon spectrum. These moments represent many physical properties at extreme temperature limits

For example ω_D (−1) and ω_D (−2) represent Debye Waller factors in the low and high temperature limits. Similarly ω_D (−3) and ω_D (2) are measures of the specific heats at low and high temperatures. ω_D (O) gives the geometric mean frequency and hence the entropy. ω_D (1) on the other hand measures the zero point energy of the crystal. Hence an estimation of the moments from reasonable phonon spectrum would be very useful. Both positive and negative moments are calculated from the present $\omega - g(\omega)$ data.

Mean while we have the experimental data for specific heats from low temperatures (Irwin and Iacombe, 1974) and now the phonon moments can be deduced just from the above measurements using the procedure due to Barron et al (1957). The measured values of the specific heats are properly corrected for anharmonicity and the harmonic part was obtained using the relation.

$$\frac{\theta_D (V_O)}{\theta_D (V_T)} = \left[\frac{V_T}{V_O} \right]^{\gamma}$$

where γ is the Gruneisen constant. From θ_D (V_O), (C_V) harmonic can be evaluated; and these C_V 's are used to derive the phonon moments. The details of these calculations are given in an earlier paper (Ramachandran and Haridasan, 1979b). Since we have already computed the phonon moments using equation (16), we can now compare these with those deducted from the specific heat data. The calculated moments from equation (16) and those obtained from experimental specific heats are shown in Table : 2

TABLE 2 :

Phonon moments

	$^*\omega_D$ (n) x 10^{-13}	
n	Sp.ht analysis	Our calculations
—2	4.05	3.168
−1	3.15	5.376
0	5.18	—
1	6.45	6.286
2	7.05	6.503
4	7.15	6.804
6	7.22	6.943

* ω_D (n) is the reduced moment defined as

$$\omega_D(n) = \left[\frac{n+3\mu}{3} n \right]^{1/n}$$

where μ_n is the nth moment.

Conclusions :

Marimuthu's calculation on the Brout sum rule revealed the existence of trace variable forces in this compound. It is to be noted that Klienman and Spitzer in 1960 assuming the Brout sum rule obtained a value for β (the compressibility) to be 7.8x10^{-13} egs. With the avilability of the of the elastic constants data in (1976) one could obtain the β value experimentally. This value turns out to be 1 216x10^{-12} cgs which is very similar to β values of Silicon and Germanium. This is another indication of the failure of Brout sum rule in GaP. The failure of Brout sum rule (or equivalently the presence of trace variable forces) Is due to either (a) the existence of like neighbour forces (b) anharmonicity (c) presence of three body interactions. Calculations on anharmonicity require knowledge of phonons from reasonable harmonic models. Thus in the present work we have incorporated item (a) and (c) together in a simple angular force model to see how far such a model explains the experimental results. The model was worked out with four parameters and the agreement with the experimental phonon dispersion was satisfactory. We state

here again that the sophisticated models like shell model with as many as 14 parameters may look to be good for interpolation purposes, but we felt that models like those employed here with least number of parameters is more desirable for explaining the general nature of binding and hence the force field. A calculation of specific heat at different temperatures shows fair agreement with the experimental results. Finally based on this model we have evaluated the phonon moments which would be highly useful to obtain estimates of many physical properties at extreme temperature limits. Thus we feel that introduction of angular forces in the dynamics of III–V compounds is more fruitful than extending the shell model with more number of parameters.

Acknowledgements :

One of the authors (K R) wishes to thank University Grants Commission, India for the award of a fellowship.

References :

Banerjee R. and Varshni Y. P. 1669 Lattice dynamics of III-V compounds, Can. J of Phy. 47, 451

Barron T.H.K., Berg W.T. and Morrison J.A. 1957 The thermal properties of alkali halide crystals II. Analysis of experimental results. Pro. Roy. soc A242, 478

Barker Jr A. S. 1968 Dielectric dispersion and phonon line shape in Gallium Phosphide Phy. Rev. 165, 917

Clark B. C. Gazis D.C and Wallis R.F. 1964 Frequency spectra of body centred cubic lattices, phy. Rev. 134, 1486

Dolling G. and Waugh J.L.T. 1963 Proc. Inter. Conf. on lattice dynamics, Copenhagen

Gopal E.S.R. 1966 'Specific heat at low temperatures' Plenum press

Covindarajan J. 1971 Lattice dynamics in crystals, Ph.D. thesis submitted to I.I.Sc, Bangalore

Irwin J.C. and Lacombe 1974 Specific heats of ZnTe, ZnSe and GaP J. App. Phy. 45, 702

Johnson F.A. 1965 Prog. semicond. 9, 179

Jules Delauney 1959 'Specific heats and lattice vibrations' Solid St. Phys Vol. 2, edited by Seitz and Turnbull

Kleinman D A. 1960a Anharmonic forces in GaP crystal, Phy. Rev. 118, 118

Kleinman D. A and Spitzer W.G 1960 Infrared absorption of GaP, Phy. Rev. 118, 110

Kunc C. Balkanski M. and Nucimovici M.A. 1975 Deformation dipole model and lattice dynamics of ziuc b blende structure compounds Phy. Rev. B12, 4346

Marimuthu T. 1977 Trace variable forces in III-V compounds, M.Phil thesis submitted to Madurai University

Martin R M. 1969 Dielectric screening model for lattice vibration of diamond structures Phy. Rev. 186, 871

Pandey B. P. and Dayal B. 1974 Lattice dynamics of CuBr and CuI by a modified rigid ion model. S.S. Communi. 15. 1667

Philips J. C. 1970 Ionicity of the chemical bond in crystals Rev. Mod Phys, 42, 317

Ramachandran K. and Haridasan T M. 1979a Angular force model for the lattice dynamics of GaSb Ind.J. of pure and app. Phy 17, 329

Ramachandran K. and Haridasan T. M. 1979b Moments of the phonon spectra of GaP, ZnSe and ZnTe Ind. J of Pure and Appl Phys. 17, 718

Reissland 1973 'Physics of phonons' Wiley Interscience publications pp 117

Sullivan J. J. and Kaplan H, 1963 Lattice vibrations of zinc blende structure crystals Phy. Rev 130, 120

Yamada 1976 Jap. J. App Phy 15, 1107

Yarnell J. L, Warron J.L. Wenzel K.G. and Dean P.J. 1968 Symp. on neutron scattering proceedings Vol : 1, PP 301.

LIMNOLOGICAL STUDY OF PONDS OF MADURAI KAMARAJ UNIVERSITY CAMPUS

V. KANNAN and S. KRISHNASWAMY
Department of Environmental Biology, School of Biological Sciences, Madurai Kamaraj University Madurai 625 021.

Abstract

The Study of various physico-chemical factors of ponds located around Madurai Kamaraj University Campus revealed that the values of total alkalinity and Biochemieal Oxigen Demand (BOD) are high only in roadside pond. The thick bloom of algae in the Microcystis pond contributes chlorophyll as much as 989.47 mg/m^3, Whereas in roadside and artificial ponds the values are 279.47 and 27.10 mg/m^3 respectively. The low oxygen value(1 2 mg/l)in oxidation pond may be due to the oxidation of dissolved organic matter. The primary production in Microcystis pond appears to be limited by shading effect of algae or photorespiration or both.

Introduction :

Limnological studies in India have been carried out mostly with reference to ponds, lakes and reservoirs (Ganapati, 1941; Sreenivasan, 1964, 1970 and 1974; Sumitra, 1969; and Kannan & Job, 1979). The interesting aspect of the temporary ponds is the diversity of life they support and their role in fixing solar energy. Studies on temporary ponds located around Madurai were done mainly with reference to biology of zooplankton (Rajendran, 1973; Kadar, 1977; and Santharam, 1979) and anostracans (Bernice, 1970 and Rayan, 1972). In the present paper a preliminary limnological survey has been made to study the temporary ponds in addition to an artificial pond and an oxidation pond located around Madurai Kamaraj Uuiversity Campus.

Study Area :

The "Microcystis pond" is a temporary pond and is characterised by the presence of a dense bloom, the dominant algae being *Microcystis* sp The "Roadside pond" is an astatic pond, in which the School of Biological Sciences of this University is raising *Tilapia mcssambica* for research work. The artificial pond is a small pond with a maximum depth of 75 cm, in which fishes caught from different ponds are introduced and maintained for later use in research. In the oxidation pond the waste water from various departments of this university is subjected to primary treatment. The surface of this pond is completely covered by a thick bloom of *Wolfia* sp.

Material and Methods :

The transparency was measured by Seechi disc. The APHA method (1969) was followed for the estimation of dissolved oxygen, Biochemical oxygen demand (BOD) and alkalinity. The pH was measured by a pH meter and conductivity by a conductivity bridge. Chlorophyll was estimated by Strickland and Parsons method (1964). For the productivity studies the Light and Dark bottle method were used (Vollenweider 1967).

Results and Discussion :

Table 1 shows an inverse relationship between transparency and chlorophyll. In the 'Microcystis pond" the low transparency is correlated with high amounts of chlorophyll and in the artificial pond, the high transparency coincides with low amount of chlorophyll and thus, the transparency is governnd by phytoplankton in these ponds. Similar findings have been reported by Sumitra (1969) and Kannan & Job (1979). A close link exists between chlorophyll, dissolved oxygen and

TABLE : 1. Physico-chemical factors of four different ponds.

No.	Parameters	Microcystis Pond	Roadside Pond	Artificial Pond	Oxidation Pond
1.	Temperaturee °C	31.50	31.00	31 00	32.20
2.	Transparency (cm)	5.00	13.00	22.50	—
3.	Dissolved Oxygen (mg/l)	20 00	12 00	8 80	1.20
4.	pH	10 40	9.20	8.30	7.20
5.	Conductivity (umhos/cm)	740.00	2,350.00	420.00	765 00
6.	Phenolpthlein Alk. (ppm)	23 00	22.00	0.00	0.00
7.	Methyl Orange Alk. (ppm)	11.00	102.00	6.60	—
8.	Total Alkalinity (ppm)	44 00	124 00	6 60	—
9.	Biochemical oxygen demand (BOD) (mg/l)	—	96.00	48.00	80.00

pH in all these ponds. The high oxygen values (20.0 mg/l) in the microcystis, roadside and artificial ponds may be attributed to the photosynthetic oxygen production (Saunders *et. al.*, 1975). In the oxidation pond, the oxygen value is less (1.2 mg/l) and this may be due to the decomposition of dissolved organic matter, which depletes dissolved oxygen in this pond. The pH in the micro-cysties pond is high (10.4) and it decreased gradually in roadside and artificial ponds, as chlorophyll value goes down correspondingly. The phenolpthalein alkalinity is nil in artificial ponds. Fairly high alkalinity in microcystis pond (23 mg/l) and roadside pond (22 0 mg/l) is correlated with high GPP (Sreenivasan 1976). The total alkalinity is less in microcystis pond, when compared to other ponds and this may be attributed to the presence of low amounts of HCO_3 ions in this pond (Hutchinson 1967). The high BOD (90 mg/l) in roadside pond coincides with the high conductivity value (2,000 umhos/cm^2) and such correlations has been reported in highly polluted area of vaigai river by Anandavalli (personnel communication) and this high BOD in this present study may be due to the activities of human beings. A moderately high BOD is also found in oxidation pond and this may attributed to the presence of high organic matter in the effulents of waste water collected from the science departments of this University. Figure 1 illustrates the GPP, NPP and respiration of ponds investigated. In microcystis pond, the chlorophyll value 984 mg/m^3 is increased three folds when compared to the roadside pond (279.89 mg/m^3). But when the GPP and NPP values are compared, in the microcystis pond the carbon fixation is slightly lower than roadside pond. So, the limitation of phytoplankton photosynthesis in microcystis pond may be either due to shading effect of the dense bloom of microcystis as reported by Sreenivasan (1976) or the prevalence of high oxygen (20 mg/l) favouring photorespiration (Zelitch, 1970); In the artificial pond, the GPP and NPP are much less, when compared to the microcystis pond and the roadside pond and this may be due to the presence of very low amounts of chlorophyll (27.0 mg/m^3).

Acknowledgement :

This work was financially supported by U.G.C. grant to one of us (S. K.).

References

Bernice, R. 1972 Biological studies on Streptocephalus dichotomus Baird (Crustacea : Anostraca) Hydrobiologia 39 : 217-240.

Ganapati, S.V. 1941 Seasonal changes in the physical and chemical conditions of a garden pond containing abundant aquatic vegetation. J. Mad, Univ. 13 : 56-69.

Hutchinson, G. E. 1967 A treatise on limnology. Vol. 1 Geography: physics and chemistry John Wiley & Sons Inc. New York.

Kadar, H.A. 1977 Studies on the biology of Spicodiaptomus. Ph.D. Thesis, Madurai University.

Kannan, V. and Job, S.V. 1980 Diurnal, depth-wise and seasonal changes of physico-chemical factors in Sathiar reservoir. Hydrobiologia (In Press).

Rajendran, M 1973 Studies on freshwater calanoids. Ph.D. Thesis, Madurai University.

Royan, J.P. 1972 Biology of Conchos traca. Ph.D. Thesis, Madurai University.

Santharam, K.R. 1979 The Biology of Daphnia. Ph.D. Thesis Madurai Kamaraj University.

Saunders, G.W., Coffman, W.P., Michael, R.C.Z. and Krishnaswamy, S. 1975 Photossnthesis and extracellular release in ponds of South India, verh. Internat. Verein. Limnol. 19: 2309-2314

Sreenivasan, A. 1964 A hydrobiological study of a tropical impoundment, Bhavanisagar reservoir, Madras State, India, for the years 1956-1961. Hydrobiologia 24:514 539.

Sreenivasan, A. 1970 Limnology of Tropical Impoundments : A comparative study of the major reservoirs in Madras State (India). Hydrobiologia 36 ; 443-469.

Sreenivasan, A 1974 Limnological features of a tropical Impoundments : impoundment, Bhavanisagar, (Tamil Nadu), India, Int. Revue ges. Hydrrobiologia 59: 327-342.

Sreenivasan, A. 1976 Limnological studies and primary production in temple pond ecosystem. Hydrobiologia 48:117 - 123

Sumitra, V, 1969 Limnological studies of some tropical ponds, Ph.D. Thesis, University of Madurai.

Zelitch, I. 1971 (Ed.) Photosynthesis, Photorespiration and plant productivity, Academic Press, New York.

STUDIES ON CERTAIN HYDROBIOLOGICAL CHANGES IN SEWAGE-FED FISH CULTURE PONDS

SAMUEL PAULRAJ & N. SUKUMARAN*

Department of Fishery Science, Tamil Nadu Agricultural University, Coimbatore 641003, India

ABSTRACT

The hydrobiological conditions in the sewage were studied both morning and evening in the sewage fed fish ponds of the Tamil Nadu Agricultural University to assess the possible transformation. pH maintained positive correlation with oxygen (r = 0. 0844). Dissolved organic matter positively correlated with BOD, carbondioxide and inorganic phosphate(r = 0.53. 0 68 and 0.7, respectively).

Introduction

Domestic, agricultural and industrial wastes are biodegradable and various methods of such waste disposals are available. They are anaerobic digestion in septic tanks, aerobic digestion in the activated sludge process or trickling filter system and digestion in oxidation ponds. Such ponds will be anaerobic due to overloading oxygen demanding wastes or poisoning of the biological system (Slack, 1972). In certain parts of the world sewage effluents have been considered too valuable to be wasted. In many parts of Asia ponding of sewage in each house is made and the effluents are used to irrigate and fertilize domestic crops. Ponding of sewage as a method of waste treatment is now regarded as most economical. The reasons for the general acceptance of oxidation ponds for waste treatment are low capital costs, insignificant operation costs and the production of effluents of acceptable quality. Here organic nitrogen, phosphorus, sulphur and other plant and animal matter are converted into inorganic salts. The chemical process involved is the biological oxidation and its success requires aerobic tension in the pond. The converted inorganic salts cause weed problem and algal blooms. In order to prevent the development of this condition in the effluent it is necessary to crop the organic production. Many methods are adapted, (a) treatment of effluents to destroy nutrients, (b) harvest of the algae for animal feed and (c) fish culture to crop excessive organic production. The first method is technically difficult and expensive and the second method depends on consumer preference and harvesting difficulties. The third is least expensive and more acceptable.

Chatterjee *et al* (1967) reported that the primary and secondary sewage oxidation ponds attached to the 'Bhilai township were used profitably for the culture of air breathing fish and carps respectively. Jhingran (1972) appraised the use of sewage water as fertilizer for fish ponds in West Bengal in India. Muthuswamy *et al.* (1974) cultured *Cyprinus carpio* in sewage fish ponds in the College of Engineering, Guindy, Madras. Boss (1944) described the practice of utilization of Calcutta sewage for fish culture.

The present study envisages the changes in the hydrobiological conditions of sewage fed fish ponds of the Tamil Nadu Agricultural University, Coimbatore. Waste waters from 239 residential quarters, student hostels, canteen and from various laboratories of the University form the sewage. The underground drainage system passes through the orchard and the sewage is let into a sump, from where it is pumped to a sewage oxidation pond I (15 m × 12.5 m) from these to

* Present address : Department of Fish Culture, Fisheries College, Tamil Nadu Agricultural University, Tuticorin-628 003 India

pond II by gravitation From the oxidation Pond II individual connections have been made to fish ponds I and II (20 × 6.5 m). Fish pond III and IV receive water from fish ponds I and II respectively and water flow is maintained by gravitational flow. Since the perculation is very high, serial connection was not made and sewage was pumped atleast 8 hrs. a day. In the Present study physico-chemical condition and their transformation have been studied from samples of raw sewage and effluents taken from oxidation Pond I & II and fish ponds I, II, III and IV in the morning before sun rise and evening before sunset to follow the changes.

Materials & Methods

Raw sewage sample was collected directly at the point of inflow. Rest of the samples were collected from the respective ponds close to their outlets Samples for oxygen analyses were collected using 300 ml BOD bottles and fixed at the site of collection. Samples for other analyses were collected using 1l polyethylene bottles. All possible care was taken during the collection. The pH was measured using a Toshniwal pocket pH meter model CL 45. The turbidity was measured at 660 μ using distilled water as blank. The percentage of transmittance was considered as an index of turbidity. All analyses were made according to "Standard Methods" (1955). The total bacterial population was assessed according to "Approved Laboratory Technic" (1969). Biological examination of plankton was carried out according to Amin and Ganapathy (1972) and the values were expressed in symbols of Fritish and Rich (1913) viz , rrr = 1; rr = 1 to 50; r = 50 to 100; c = 100 to 200; cc = 200 to 500 ccc = 500 and above.

Results & discussion

The value for pH and phenolphthalein alkalinity show that the entire system was alkaline (Table 1). Any soluble organic acids

TABLE : 1 Hydrobiological ehanges in raw sewage and various ponds

Variable		Raw sewage	Oxidation Pond 1	Oxidation Pond II	Fish Pond I	Fish Pond II	Fish Pond III	Fish Pond IV
Turbidity as	@	90.0	90 0	90 0	94.0	96.0	96.0	99.0
Transmittance	£	90 0	85 5	97.5	100.0	100 0	100.0	100 0
p^H	@	8 2	8.2	8.2	8.5	8.6	8.7	8.2
	£	8.1	8.3	8 6	8 75	8.2	8.2	8.4
Suspended	@	33.2	27.0	30.0	20 0	16.5	25.0	18.0
matter mg/l	£	510.0	300.0	145.0	40.0	98.0	62.0	21.0
Conducitivity	@	0.716	1.232	1.502	1.502	1.540	1.525	2.050
($\times 10^{-3}$) mhos	£	1.925	1.925	1.925	1.540	1.540	1.155	1.348
Dissolved oxygen	@	Nil	Nil	0 4	6.4	11 6	10.4	6 0
mg/l	£	Nil	Nil	2.8	2.8	1 2	3.2	6 0
Dissolved Carbondioxide	@	8 0	20 0	18 0	20 0	6 0	Nil	Nil
mg/l	£	32.0	14.0	Nil	Nil	4.0	4.0	Nil
Phenolphthalein								
alkalınity as	@	20 0	32.0	50.0	50.0	50.0	45.0	50.0
$CaCO_3$ mg/l	£	Nil	Nil	6.0	14 0	6.0	6.0	14 0
Methyl orange								
alkalinity	@	260	420 0	440 0	450.0	450.0	430.0	470.0
as $CaCO_3$ mg/l	£	420	370.0	310.0	300.0	330.0	290.0	290.0
Dissolved organic								
matter	@	4.0	17.2	14 6	16.4	16 0	7.2	6 4
as oxygen mg/l	£	22.0	24.4	19.0	10.0	7 6	6.4	8.0
BOD mg/l	@	216.0	186.0	165.0	112.0	124 0	116.0	120.0
	£	315.0	192.0	202.0	132.0	140.0	130.0	140 0

Ammonia nitrogen	@	1.59	2 21	2.13	2 42	2.38	2.25	2.13
mg/l	£	4.7	12.6	3.8	0.70	2 0	0.20	0.20
Inorganic								
Phosphate as	@	0 828	1.948	2.04	1.976	1 392	1.392	1 904
P. mg/l	£	2 088	2 088	1.220	0.396	0.660	0.138	0 120
Silicate Si.	@	100 0	110 0	107.0	107.5	107 0	111.0	110.0
mg/l	£	138.0	157.0	204.0	185 0	177 5	187.0	138 0
Chloride	@	240.18	350 52	320.30	340.62	320 00	390.40	280.10
mg/l	£	219.77	212.565	257.60	108 08	104.48	59.45	81.06
Total hardness as	@	210 0	370 0	382 0	423 0	381 0	379.0	405.0
$CaCO_3$ mg/l	£	381.0	360.0	463 0	265 0	240.0	240 0	195.0
Calcium hardness as	@	122 0	215.0	177.0	179 0	170 0	220.0	201 0
$CaCO_3$ mg/l	£	207 0	175 0	81.0	119.0	118.0	99.0	100 0
Bacteria	@	60 9	88.8	78 0	134.4	3.2	8.1	31.7
($\times 10^6$/ml)	£	73.6	832 0	524.0	444.0	52 8	49 6	129 6
Ciliates	@	Nil	Nil	Nil	Nil	Nil	Nil	Nil
per ml.	£	Nil	rr	Nil	Nil	Nil	Nil	rr
Rotatoria	@	Nil	Nil	Nil	Nil	Nil	cc	rr
per ml.	£	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Copepodes	@	Nil	Nil	Nil	Nil	Nil	Nil	rr
per ml.	£	Nil	Nil	rr	rr	rr	rr	rr
Algae	@	rr	Nil	Nil	Nil	rr	ccc	r
per ml.	£	Nil	c	ccc	cc	ccc	Nil	ccc

£ Morning @ Evening

rrr = 1, rr = 1 to 50, r = 50 to 100, c = 100 to 200, cc = 200 to 500 and ccc = 500 and above.

resulted from carbohydrate metabolism would be indicated by a drop in the pH. As significant drop in the pH was not noted at any time it must be concluded that such products were not formed at all or formed in meagre quantity. Higher pH was recorded during day in fish ponds II and III and algal matters in those ponds were also high. Dissolved oxygen also registered the highest value in these ponds during day time. Higher pH value shows that the photosynthesis exceeds respiratory activities leading to supersaturation of oxygen. It is evident that the increase in pH alone with phenolphthalein alkalinity is due to the photosynthesis of the algae present. During this period algae utilise the carbondioxide from the bicarbonate alkalinity making the system alkaline due to the formation of carbonates. In consequence a low value of carbondioxide was noticed in these ponds. Higher the phenolphthalein alkalinity greater the reduction of oxygen due to photosynthesis. pH has maintained a positive correlation with dissolved oxygen (r' = 0.0344).

Dissolved oxygen is vital to break the complex organic matter to its final products as carbondioxide, ammonia and water. Strictly there was no oxygen in the oxidation ponds either in the morning or in the evening, which proved that in the bacterial phase the rate of oxygen consumption by the microbes is higher than the diffusion of atmospheric oxygen into the liquid system. The same condition was observed in the field study of Ramakrishnan and Ganapathi (1972). Sufficient oxygen will be available for metabolic processes once algal synthesis starts. Algal synthesis in the successive ponds created sufficient oxygen in the medium which was evident by the very low oxygen tension in the early morning. The marked drop in dissolved oxygen than expected in fish pond II in the morning was due to the higher concentration of phytoplankton.

When compared with the oxidation pond I, the average reduction in BOD in fish ponds III and IV were only 54 6% during day and 43.0% during night. The above values are very low, when compared with the algal phase of the laboratory model sewage system, where the reduction was 73% (Ramakrishnan and Ganapati, 1972) and in the laboratory scale pond where the reduction was 97% (Amin and Ganapati, 1972). The low value for 5-day BOD reduction accounts for its very high continuous loading which was inevitable due to excessive seepage of the soil A vast difference in the BOD of morning and evening was noticed. However, Oluwande *et al.* (1974) describes that the BOD may change as per different feeding habits. The BOD of the sewage fed fish pond effluent was studied to be between 5 to 15 mg/l in the Department of Public Health Engineering, Guindy. Muthusamy *et al.* (1974), Ramakrishnan and Ganapati (1972) found in their field studies that the BOD values for the final effluents were very low (1.5 to 6.0 mg/1) and was almost equal to the river water.

Dissolved organic matter maintained a positive correlation with BOD (r = 0 53), carbondioxide (r = 0.68), and inorganic phosphate (r = 0 7). The concentration of phosphate decreased gradually from the oxidation ponds but the reduction was very meagre. Amin and Ganapati (1972) found that the removal of phosphate was much less than that of ammonia nitrogen. The concentration of phospate was found to be very high. Ghosh *et al.* (1974) reported that the phosphorus and nitrogen contents both in soil and water phases are quite high even after utilization by primary producers. The reduction in ammonia nitrogen indieates the synthesis of cell growth and the algae developing in the fish ponds might have used this nitrogen to build up-the protein which is the basis of their cellular protoplasm. It is very apt to note that the bacterial population and the occurrence of ammonia positively correlates (r = 0.7157). But no significant decrease of ammonia nitrogen was noticed, which may be due to the hydrolysis of protein.

References

Amin, P.M. and Ganapati S.V.	(1972)	"Biochemical changes in oxidation ponds". J. wat. poll. control Fed. Washington, 44, 183 - 200.
	1969	"Approved Laboratory Technic" 5th Ed. Scientific Book Agency Culcutta.
Bose, P.C.	1944	Calcutta sewage and fish culture. Proc. Nat. Inst. Sci. India 10, 443 - 450.
Chatterjee, A N., Arora, B.K and Gupta, D. R.	1967	"Some observation on utilization of sewage or fish culture in oxidation ponds". Environ. Hlth., 9, 156-161.
Fritsch, F.E. and Rich, A.	1913	"Studies on the occurence and reproduction of British freshwater algae in nature. 3. A. four years observation of a freshwater pond". Ann. Biol. Lacus., 6, 33.
Ghosh. A., Hanumantha Rao, L. and Banerjee, S.C.	1974	"Studies on the hydrobiological conditions of a sewage fed pond with a note on their role in fish culture". J. Indian. Fish. Soc. India. 4, December, 1974.
Jhingran, V.G ,	1972	"A critical appraisal of the water pollution problems in India in relation to aquaculture". FAO Indo Pacific Fish. Council (15th Session) IPEC/72. p. 45.
Muthusamy, S., Goviadan, S. and Sundaresan, B.B.	1974	"Productivity of Cyprinus carpio in stablization pond effluents". Indian J. Enviran. Hlth., 16, 370 379.
Oluwande, P.A., Jibodu, K.O. and Finley, W.W.	1974	"Biochemical oxygen demand (BOD) characteristics of sewage of people on Nigerian diets". Indian J. Environ. Hlth,, 16, 34-45.
Ramakrishnan, C.V., and Ganapati, S.V.	1972	"Studies on sewage purification". Technical report of PL 480 Project FG-in-245. Sponsored by the United States Depart. ment of Agriculture, Washington, USA.
Slack, E.B.	1972	"Sewage and aquaculture production" FAO. Indo Pacific Fish. Council (15th session) IPFC/72. p. 70.
	1955	"Standard Methods for the Examination of Water and Waste Water". 10th Ed., Amer. Pub. Health. Assn., New York, N.Y.